A STUDY OF ADVENTITIOUS BURSITIS OF THE HOCK OF THE PIG

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A thesis submitted for the degree of Doctor of Veterinary Medicine and Surgery

UNIVERSITY OF EDINBURGH

1992

FRONTISPIECE

The left hind leg of a pig at slaughter with an adventitious bursa on the lateroplantar aspect of the hock

Foreword

The large mass of data collected at the abattoir resulted in a file with 13 units of information on each of 14,046 pigs being compiled. It was decided to store this large amount of information on hard disc, not only so as to reduce its bulk, but also to protect the identity of individual farms which were 'flagged' by slap mark. This disc, with notes on access information and description of files, has been lodged with the librarian of the Royal (Dick) School of Veterinary Studies, University of Edinburgh. A copy has been retained by the author.

During the period of study, advantage was taken of the opportunity to collect data from pigs reared on farms belonging to research institutions. On these farms, identification procedures and storage of information was detailed and this was found to be of great benefit. The majority of farmers who were approached, with a view to studying their pigs and systems, were interested in the work and cooperated in every way. Indeed, many benefited from *ad hoc* information, collected at the abattoir or on the farm, regarding the health of their pigs.

Acknowledgements

I am particularly indebted to Mrs Moira Morgan who collected many of the data, often in difficult circumstances and without complaint. Indeed, her enthusiasm and sparkling personality, frequently overcame frustrating problems which arose on the farm or at the abattoir. I also wish to express my thanks to those farmers, stockpersons and abattoir staff whose willing cooperation made this study possible. The comments and help received from my colleagues was also a great help and inspiration. In particular, I wish to thank Dr K Linklater, Director of SAC Veterinary Services whose support and encouragement enabled this project to be undertaken during an otherwise busy schedule. Dr M Franklin and Karen Robertson of the Scottish Agricultural Statistics Service handled and analysed large amounts of data with great skill and patience. The advice and detailed explanations regarding trends and relationships between various parameters, was greatly appreciated. The comments and helpful advice received from Professor J Boyd (anatomy), Drs J Webb and P Bampton (genetics), Dr J Thomson (histopathology), A Rowland (advice) and G Halliday (computer data handling) were greatly appreciated.

The many discussions and debates with Professor R H C Penny were very helpful and provided a much needed stimulus at times. I am also grateful to Dr R Munro who supplied plates 3.19-3.22. Dr J Bruce kindly gave permission for use of Figure 6.1 and Professor Sachs gave permission for the use of Figure 3.2.

Finally, I wish to express my sincere thanks to Mrs Diane Stuart, for whose patience and understanding while typing the manuscript I will always be grateful.

Declaration

The work was planned and carried out by myself apart from help received from persons acknowledged above.

The project was assisted by a grant from The Scottish Office Agriculture and Fisheries Department (SOAFD).

ABSTRACT

A review of the literature showed that adventitious bursitis was recognised in most European countries with large pig populations. On the whole, there was agreement that hard floors without bedding played a significant role in the pathogenesis of the disorder.

An abattoir study was conducted in five Scottish abattoirs in order to establish the prevalence and severity of adventitious bursitis in finished pigs. Data were collected from 14,046 pigs of which 7,350 were male and 6,696 female. Adventitious bursitis of the hock was noted in 12,220 pigs (87%) and the mean severity score was 1.598 (score range 0-4). Bursitis was present on the left leg of 11,579 pigs (82.436%) and in the right leg of 11,558 pigs (82.286%). The prevalence of bursitis in males and females was 87% and 86% respectively. The prevalence of bursitis in winter (87.5%) was higher than in summer (84.5%) while the severity score in winter (1.65) was also higher than in summer (1.47). Adventitious bursae on the hock were found on three aspects: plantar, lateroplantar or medial. When bursitis was present it was usually bilateral and in every case the bursae were present subcutaneously over the plantar aspect of the lower calcaneous, or the lateroplantar aspect of the lower calcaneous or the promontory of the central tarsal bone. A histopathological study suggested that bursae arise as a result of pressure trauma on lymphatic vessels and capillaries which resulted in the exudation of fluid and fibrin. This fluid filled sac became walled off by fibroblasts.

Adventitious bursae were also noted on the forelegs and over the points of the hocks (capped hock). The prevalence of capped hock in males (3.58%) was higher than in females (1.97%) and when capped hock was present, bursae on other aspects of the hock were either small in size or completely absent.

It was shown that infection played no role in the pathogenesis of the lesions.

A farm housing survey showed that there was an association between pigs with bursitis and rearing on hard floors. Further studies on pigs from birth to slaughter, indicated that bursitis developed early in life (< 3 weeks of age) but only did so when the floors were hard, with the prevalence and severity of bursitis being highest on concrete slats. Deep bedding not only prevented bursitis but also reduced the prevalence and severity of bursae already present.

It was also shown that the degree of bursitis increased on the Straw-Flow system which was developed mainly for welfare reasons. There was a good correlation between the prevalence of foot-rot lesions and the severity of bursitis. Concrete with a rough abrasive surface caused a high prevalence of foot-rot lesions and a high frequency of bursae with erosions.

Data from one herd with a bursitis problem showed that bursitis was moderately heritable, i.e. about 25% of the variation in severity was genetic in origin. Other important determinants included the depth of subcutaneous fat, breed and skin thickness.

The main economic impact was due to the weight of tissue condemned and the number of breeding stock rejected for breeding purposes. Bursitis cost the Scottish pig industry about £406,000 in 1991.

A high prevalence and severity of bursitis might indicate a welfare problem but a modest degree of this 'blemish' was thought to be acceptable as there were good reasons for supporting the housing systems involved.

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Chapter 1

REVIEW OF THE LITERATURE

Introduction

Adventitious bursitis is presently defined (Oxford English Dictionary) as accidental or causal inflammation of the hock area resulting in the formation of a subcutaneous false bursa. Le Gros Clark (1958) described a bursa as follows "*......the connective tissue may become so loose and open in texture as to be converted into a well-defined and circumscribed sac in which flattened fibroblasts form a smooth mesothelial lining apparently identical with the synovial lining of the joint cavity. These sacs are called* bursae *(also known as hygromas). They function as small water cushions in minimising the effects of pressure and friction, and they contain a minute amount of fluid similar to the synovial fluid of a joint. Subcutaneous bursae may develop over bony prominences which lie immediately deep to the skin, but it is probable that, as well-defined sacs, these only appear adventitiously in response to some trauma.*" A bursa is a small fluid-filled sac or sac-like cavity situated in places in tissues where friction would otherwise occur. (Blood and Studdert, 1988). Schmidt (1936) noted that subcutaneous synovial bursae arose at exposed places within subcutaneous connective tissue, in response to mechanical insults, by atrophy of connective tissue bundles, which gradually formed smooth-walled, fissure-shaped cavities usually not lined with endothelium. An acquired bursa has been defined as a bursa that develops as a result of trauma where a natural bursa is not normally present (Adams, 1974).

"Pseudocysts" were first noted in Czechoslovakia in the 1960's and were reported by Groch (1970) within the framework of a research project and were more fully discussed by Groch *et al.* (1986).

In Sweden, Sandstedt and Carlquist (1951) studied the disorder in finishing pigs and the condition was also the subject of a study by Backstrom and Henricson (1966). In Denmark, Nielsen (1988) described outbreaks of Enzootic Bursitis of the hock in growing pigs. These lesions were also referred to as pseudocysts by the same author and the description given would indicate that an adventitious bursitis of the hock was involved.

Adventitious bursitis was described in Germany by Behrens and Richter (1963) and reported in more detail by Behrens and Trautwein (1964). Penny *et al* (1963) first described the condition in the UK.

Thus, it would appear that adventitious bursitis of the hock became prevalent in the early 1960's in at least five countries with large pig populations. It is perhaps of importance to note that the pig industries in these countries had recently undergone marked intensification, resulting in larger numbers of pigs being kept by fewer people, in higher stocking densities, on perforated floors or solid floors with no bedding. These changes were discussed in detail by Alexander (1971).

Prevalence

Orsi (1967) examined a total of 2,888 pigs on two state farms and found that almost half the pigs on one farm (SF) had evidence of bursitis on one or both hocks and just over a quarter of pigs on the other farm (CF) were likewise affected (see Table 1.1).

Table 1.1: Incidence of Swellings of the Hock Region - Orsi 1967 (adapted)

Unit	No. of Pigs	Number Affected	Affected %
SF	1,208	577	47.7
CF	1,680	456	27.1

Penny et al (1963) in an abattoir survey in the UK, described "*a commonly encountered condition .... a chronic inflammation of an adventitious bursa on the postero-lateral area of the hock.*" Penny *et al* (1972) in a letter to the Veterinary Record about tail-biting, mentioned the high incidence of adventitious bursitis of the hock i.e. 58.2%. Penny and Hill (1974) examined 11,811 pigs in one abattoir over a 12-month period and commented on the increase in prevalence since the 1963 study by Penny *et al* (see Table 1.2)

Table 1.2: The Prevalence of Bursitis of the Hock, Penny & Hill (1974) adapted

Total No. of Pigs Examined	No. Affected	% Affected
11,811	8,681	73.4

In a study conducted at one abattoir in the UK, 858 (6.4%) hocks were removed from 13,358 pigs by the meat inspectors (for all reasons). Hocks which were trimmed only were not included in these figures. However a clinical inspection of 1341 pigs immediately before slaughter revealed that 343 (25.6%) had evidence of bursitis in one or both hind legs (Marchant 1980).

In Sweden, Backstrom and Henricson (1966) conducted a slaughterhouse survey and noted the frequency of lesion expression. See Table 1.3.

Table 1.3: Frequency of Adventitious Bursitis of the Hocks in Slaughterhouse Pigs. Backstrom and Henricson (1966) adapted

Slaughterhouse	No. Inspected	No. Defective	Frequency %
Skora	3,027	1,157	38
Stenstork	3,006	1,050	35
Laves	1,009	339	34
Total	**7,042**	**2,546**	**36**

In the same country, Skärman (cited by Backstrom and Henricson (1966)) noted that 51% of 2474 pigs suffered from adventitious bursitis of the hock. In an abattoir study involving 1,000 pigs, Penny (1987) noted a prevalence of 58%.

In another small study involving 436 bacon pigs, Smith and Thomson (1987) noted a prevalence 98%. (see Table 1.4). More recently Probst *et al* (1990) studied the effect of different housing conditions (floors) on the prevalence and severity of both foreleg and hindleg lesions. They noted that the prevalence and severity of adventitious bursitis in the latero-plantar area started within the first two weeks of life and increased in severity as the pigs aged. In one study, of 40 pigs housed on partly-slatted floors with no bedding, they noted that nearly 90% had evidence of bursitis in the lateroplantar area, while in another study of 55 pigs housed on deep bedding (from 5 weeks of age) they noted that approximately 5% had evidence of lateroplantar bursitis at slaughter. The difference between the two groups was significant. It should be noted that over 40% of pigs in the latter group had evidence of bursitis at weaning (5 weeks of age).

Berner *et al.* (1990) studied adventitious bursitis in both sows and finishing pigs. They referred to the bursae as Auxiliary Synovial Bursae (ASB). On one farm, 102 sows were kept in concrete stalls with light bedding (straw), while on another farm 168 sows were kept in concrete stalls with a cast-iron slatted area at the rear: 42% of the sows kept in the concrete stalls with a small amount of chopped straw had evidence of adventitious bursae, while 59.5% of sows in the stalls with cast-iron slats had bursae. The bursae in the latter group had a greater diameter and they were significantly more numerous than in sows in concrete stalls. However, the authors neither specified to what extent the sows had bursitis when they were first placed in the stalls, nor did they mention the type of floors the sows had been reared on before the trial began.

Berner *et al* (1990) also examined 27 finishing pigs kept on fully-slatted concrete floors on a regular basis (frequency not specified) until slaughter. The age or weight at the beginning of the observation period was not given. At the beginning of the finishing period only 7.4% of the pigs had bursitis, but by the end of the period 26 of the 27 pigs (96.3%) had bursitis.

Thus there is evidence to suggest that bursitis has become more common as the pig industry has intensified its housing systems.

Table 1.4: Prevalence of Bursitis of the Hock in Pigs: an Abattoir Study. Smith & Thomson (1987)

Abattoir	No. of Pigs Inspected	No. of Pigs Affected	% Affected
David Hall	436	428	98.16

Nielsen (1988) studied five herds in detail and noted that the prevalence of the disorder varied from 40-75% in pigs of approximately 3 months of age. However, this level of prevalence was only noted over a period of 1-2 months and thereafter cases became sporadic.

Senior Meat Inspectors at three large abattoirs processing over 4,000 pigs per week in Scotland, were all of the firm opinion that adventitious bursitis of the hock was becoming more prevalent.

Distribution of Lesions

Bursae are usually reported as lying on the plantar aspect of the hock, or on the lateroplantar aspect opposite the fourth tarsal bone or in line with the metatarsal. There is comparatively little information on this aspect. Orsi (1967) examined a total of 2,008 pigs on two farms and noted the following distribution of lesions in those affected. (see Table 1.5)

Table 1.5: Position of Swellings in the Hock Region. Orsi (1967)

Unit	Incidence of Swellings								
	Right Hind Leg			Left Hind Leg			Both Hind Legs		
	Total	LP	P	Total	LP	P	Total	LP	P
SF	163	109	54	165	116	49	249	153	96
%		(66.8)	(33.2)		(70.3)	(29.7)		(61.4)	(38.6)
CF	117	97	20	146	98	48	195	108	87
%		(82.9)	(13.1)		(67.1)	(32.9)		(54.9)	(45.1)

LP = Lateroplantar
P = Plantar

There was no significant difference in the distribution of lesions between the hind legs. Of the pigs affected, more than twice the number had both hind legs affected. Groch *et al* (1986) noted that the prevalence of bilateral bursitis increased as the weight increased. (This could also have been a factor of age, see Table 1.6).

Table 1.6: The Prevalence of Bursitis and Range in Weight. Groch et al **(1986) adapted**

No. of Legs	Weight Range (kg)	% Affected	% Both Legs Affected
31	5-15	6.5	0
35	15-30	34.4	16.7
50	30+	54	37.0

These authors also mentioned the presence of 'tendosynovial pseudocysts' on the medial-plantar surface of the metatarsus. Probst *et al* (1990), in an experimental housing study, noted that adventitious bursae might be present on the caudo-lateral area of the hock or the caudo-medial area but gave no data relating to the distribution of the lesions. Penny and Hill (1974) in an abattoir study of 11,811 pigs noted that "*the lesions were invariably bilateral*" but did not present exact data. Backstrom and Henricson (1966) made the comment "*the protuberances are in most cases bilateral albeit of unequal size*". These authors provided no data to support the observation. More recently in a small survey of 436 pigs at the abattoir, Smith and Thomson (1987) noticed that if bursitis was present then it was always present to a greater or lesser degree in both legs (see Table 1.7).

Table 1.7: Bursitis of the Hock in Pigs - An Abattoir Study. Smith & Thomson (1987)

No. of pigs Inspected	No. of pigs Affected	%	% Both legs
436	428	98.16	98.16

Thus the available evidence suggests that as the prevalence of bursitis increases the likelihood of the lesion being present in both legs also increases.

Nielsen (1988) stated that the bursae were most frequently located on the lateroplantar area of the hock of pigs of 10-12 weeks of age but gave no detailed information of the exact distribution of these lesions (studies in five herds). Berner *et al* (1990) noted that adventitious bursae in sows were to be found over two bony prominences:

(a) the lateroplantar area of the calcaneus and fourth tarsal bone, and
(b) over the plantar sesamoid bone.

In finishing pigs they noted bursae appeared:

(a) over the lateroplantar area of the calcaneus and fourth tarsal bone, and
(b) on the plantar surface of the calcaneus

These workers discussed reasons why sows should develop bursitis over the sesamoid bone (medial aspect) when the finishing pigs did not. They came to the conclusion that the shape and prominence of the sesamoid bone in sows was the main determinant. However, they only examined 27 finishing pigs and it is quite probable that, had they examined more, they would have come across cases of bursitis over this area in the finishing pig. Thus, the only detailed information regarding the distribution of the lesions was provided by Orsi (1967), while the presence of a bursa on the medial aspect in finishing pigs was mentioned by Groch *et al* (1986) and in sows by Probst *et al* (1990) only.

Sex Effect

In an abattoir survey, Penny and Hill (1974) noted 76.2% of 5,690 male and 70.8% of 6,121 female pigs showed evidence of bursitis. There was no significant difference between the groups.

In Sweden, Backstrom and Henricson (1966) noted that 50% of male and 55% of female Landrace pigs reared in a testing station showed evidence of bursitis at slaughter. In the same study they also noted that 73% male and 72% female Yorkshire pigs had developed some degree of bursitis by the time they had reached slaughter weight. There was no significant difference in the prevalence between sexes. (see Table 1.8)

Table 1.8. Frequency of Bursitis at Slaughter.
Backstrom & Henricson (1966) (adapted)

Breed	**Sex**	**% Affected**
Landrace	M	50
	F	55
Yorkshire	M	73
	F	72

In Hungary, Orsi (1967) made the comment "*we can safely conclude that sex has no significant role in the causation of the swellings*" but gave no data to support this statement.

In the UK, Smith and Thomson (1987) noted that 97% of male pigs and 99% of female pigs were affected with bursitis. Again there was no difference between the sexes.

Genetic Effect

Penny and Hill (1974) attempted to divide the pigs at the abattoir into three main genotypes (see Table 1.9).

Table 1.9: The Prevalence of Bursitis of the Hocks and other Skin Conditions. Penny & Hill (1974)

Approximate Breed	No.	% Bursitis
Prick-eared	3,051	77.8
Lop-eared	2,266	74.9
Saddleback x	363	64.5
Total	**5,690**	**76.2**

There was no difference in prevalence between the prick-eared "large white type" and flop eared "landrace type". However, the percentage of saddleback pigs affected was lower at 64% and the authors made the comment that such pigs were likely to be reared in a different environment, often outdoors.

Behrens and Trautwein (1964) stated that they had only seen subcutaneous bursae in improved Landrace of Danish-Dutch extraction, but never in the old type of indigenous Landrace.

In Hungary, Orsi (1967) noticed that bursitis was more prevalent in the white breeds as opposed to coloured breeds reared on the same farm. In one particular farm, 33% of white porkers were affected but none of 110 Danish Red or Mangalitsa gilts showed evidence of the lesions.

Groch *et al* (1986) referred to the bursae as "inherited polygenic pathological changes" and later talked about "selection against this inherited disorder". The same authors then mentioned **inherited susceptibility** suggesting that the disease is not truly inherited after all.

Backstrom and Henricson (1966) noted a boar effect on one farm. In another study the same authors noted that a significantly higher number of Yorkshire pigs would develop lesions compared with Landrace in the same environment. They also provided data to show that the heritability in four herds was 0.6, 0.12, 0.90 and 0.44%; (mean 0.56). These authors also quote the experience of breeders who often noticed a relationship between the prevalence of bursitis and use of a particular boar. In another herd of five breeding sows and one boar, the same authors noted that the prevalence of bursitis in the offspring was unusually high and even piglets of 3 to 5 weeks old were affected. However, when two of the sows were mated to a different boar, the offspring did not develop bursitis. In another three herds studied by the same authors, special attention was paid to the bursitis-status of the parents. When an affected boar in one herd was mated with normal or affected sows, the offspring of the affected dams had a significantly higher prevalence of bursitis. However, when affected or normal sows were mated to a normal boar there was no significant difference in the prevalence of bursitis between the offspring. They estimated that the heritability was 0.60 if the sire was affected and 0.12 if the sire was normal. However, the authors did not describe the type of housing in which the parent stock had been reared. From three particular herds, they also made the observation that sows affected with bursitis had, on average, larger litters than normal sows. Backstrom & Henricson (1966) suggested that hereditary predisposition was brought about through inferior tissue quality, but they also theorised that the angle between the lower edge of the hock bone and the metatarsus might also be a factor. They noted that the Yorkshire breed had straighter hocks and this might explain the higher prevalence in that breed. However, Orsi (1967) was of the opinion that the shape of the hock was irrelevant, as the prevalence of the condition was equally common in pigs with both 'curby' hocks and normal hocks. Thomas (1984) reported that bursal swellings behind the hocks were common in store pigs where a 4-5 inch step to the dunging area was present. However, no data were produced to substantiate the statement. Sabec (1987) noted that broader hams were accompanied by more bursitis, because animals with this type of conformation spent more time lying down.

Watson (1987) noted that the condition was commonly seen in modern white breeds, as opposed to the Duroc or Chester White "where the condition was seldom seen". Skärman (1963) cited by Bäckström and Henricson (1966) noted that, in a breeding trial involving 2474 pigs, 43% pure Landrace pigs developed bursitis while 59% of pure Yorkshire pigs showed evidence of the disorder. The value for the crossbreds lay between those for the purebreds. The same authors also noted a high frequency of severe bursitis in finishing pigs which had been reared on an earth floor and with an abundance of straw litter (but did not specify how hard the floor was). They concluded that inherited susceptibility can be very important in the development of the disease. Probst *et al* (1990) concluded from their studies that inherited susceptibility did not play a role. However, they provided no data to substantiate this observation. They did make the comment that if there was a real genetic effect it would explain why some pigs react to constant irritation of their tissues by forming connective tissue proliferations and others react by forming subcutaneous bursae. Likewise, Berner *et al* (1990) concluded that heritability did not play a role, but the design of the study they carried out could not have demonstrated a genetic factor anyway.

In summary, there is enough subjective evidence to suggest that the offspring of the Yorkshire breed (Large White) are more susceptible than the offspring of the Landrace breed to adventitious bursitis of the hock. The results of one study suggested a heritability of 0.36 in the Yorkshire breed, ie 36% of the variation in severity of the condition is genetic in origin.

Intercurrent Disease and the Role of Infection

Marchant (1980) cultured the contents of 163 bursae from hocks condemned by meat inspectors at the abattoir. Fluid contents were withdrawn aseptically from 66, while a plug of tissue was taken from those bursae which were solid, again by aseptic technique. Cultures were sown on blood agar and suitable mycoplasma media. Bacteria were grown from 23 fluid samples and 34 plugs, a total of 57 (34.9%). Of the isolates, 29 were Streptococci (1 Group B, 1 Group C, 2 Group G and 25 unclassified) and 13 were Staphylococci (3 coagulase +ve and 10 coagulase -ve). There was no difference in the isolation rate irrespective of whether those isolates come from clear, turbid or blood-stained fluid. It was concluded that the wide range of isolates suggested the organisms isolated were opportunist invaders, of sites damaged by trauma, probably from the environment.

Glawischnig (1965) in Austria, noted an adventitious bursitis of the hock in pigs of 3-6 months of age, especially in herds with *Atrophic rhinitis* or *Enzootic pneumonia* and came to the conclusion that a *Pleuropneumonia* organism (PPLO) was involved - the assumption being that both diseases were caused by PPLO. However, on culturing many of these bursae he was only able to isolate a *Haemophilus* species from a single bursa. In Germany, Behrens and Trautwein (1964) examined 12 bursae culturally, but failed to prove any causal relationship with an infectious agent. Backstrom and Henricson (1966) noted that some of the bursae may become secondarily infected and then they may rupture. They noted that enlargement of bursae at other sites, for example the carpus, was often seen in conjunction with adventitious bursitis of the hock. When carrying out post mortem examinations of pigs with bursitis, they noted that three showed anaemia, gastro-enteritis was present in one and an alveolar-cell pneumonia in another. They could find no evidence of disease of the joints or skeleton. Cultures made from many bursae proved to be negative for bacteria, except for three cases from which Staphylococci, and one from which beta haemolytic Streptococci, were isolated and considered to be secondary invaders or contaminants. When they investigated the relationship between bursitis and atrophic rhinitis they could find no evidence to suggest a link between the two diseases. They did however, note that 55% of pigs with no lung lesions had no evidence of bursitis whereas 66% of pigs with pneumonic lesions had lesions of bursitis. The difference was significant. They made the comment that the uncomplicated lesion never resulted in lameness.

In Hungary, Orsi (1967) also reported that bursitis lesions never caused lameness or a reduction in performance. He could find no evidence of bone disorders after subjecting an unspecified number of pigs to X-ray examination.

In Czechoslovakia, Groch *et al* (1986) noted 32% of pigs with bursitis also had a bursa on the tuber calcanei i.e. capped hock. They commented that environmental conditions conducive to the development of bursitis also led to an increasing frequency of other leg disorders.

Penny *et al* (1963) inspected over 11,000 pigs at two slaughter houses and found that 65% of these had some evidence of footrot in one or more claws. At another abattoir, Penny & Hill (1974) noted that over 70% of pigs had evidence of adventitious bursitis of the hocks as well as lesions at other sites. The conditions mentioned included tail-biting 11.6%; necrosis of the tail tip 23%; ear haematoma 0.38%; capped hock 22%; transit skin erythema 30% and ear-biting 0.45%.

Doman (1966) also commented that when conditions giving rise to bursitis were present he also noted high levels of other conditions such as pachyderma, abscesses, arthritis and ulcerative wounds. After studying outbreaks of severe *Enzootic bursitis* in five herds, Nielsen (1988) cultured *Mycoplasma hyorhinis* from the bursal contents of two pigs, 5 weeks and 11 weeks old respectively. Interestingly, Nielsen then stated that media incubated both aerobically and anaerobically were all sterile if samples were taken from **unruptured** bursae. The same author also noted that the bursae enlarged markedly after the affected pigs were transferred from weaner accommodation to the finishing accommodation. At the same time, many pigs became lame, but there was no pyrexia or other evidence of clinical illness. The lameness was mainly associated with *Mycoplasma hyosynoviae* arthritis. A considerable proportion (5-10%) of these bursae ulcerated and became contaminated with various pyogenic organisms, in particular *Actinomyces pyogenes* and *Staphylococcus aureus*. These pyogenic infections resulted in a total of 292 (14.6%), 140 (5.4%) and 85 (6.6%) pigs dying or being totally condemned at slaughter from finishing herds of 2000, 2600 and 1280 pigs respectively. If lameness was present, Bollwahn (1980) concluded that another disorder such as arthritis or footrot was the cause. Probst *et al* (1990) subjected 24 forelegs and 52 hindlegs with bursae in various sites, to radiological examination, but found no skeletal lesions. These workers also cultured the fluid contents of 35 bursae on various media (including that for mycoplasma). A few Streptococci and Staphylococci were isolated but no mycoplasma, and it was concluded that these findings were of no significance.

Berner *et al* (1990) examined the correlation between adventitious bursae and the presence of hind leg disorders and skin lesions in sows kept in solid concrete stalls, or concrete stalls with cast-iron slats at the rear. They noted a positive correlation between the prevalence and severity of bursitis and an unsure gait (tripping, trembling and lying down quickly after rising). The occurrence of adventitious bursae was related to kyphosis of the spine, false posture of the hind legs, hyper-extension of the fetlock, arthrosis of the hock joint and claw damage. They also noted that the number of bursae increased as the animals became older and heavier, but this might of course, also have been a function of the time spent on hard floors. Berner *et al* (1990) also examined the skin in the region of the bursae. Sows kept on the concrete slats showed reddening of the skin in the region of the bursae while some sows on the cast-iron slats also developed abrasions of the bursal surfaces. In 5% of sows these injuries were quite deep (see Table 1.10).

Table 1.10: Clinical investigative findings on the skin of sows which have bursitis (from Berner et al 1990)

Findings	Pig Unit A Solid Concrete*		Pig Unit B Cast Iron Slats	
	T4	Os Ses.	T4	Os Ses.
Unchanged	7	5	7	4
Slightly Hairy	34	38	25	43
Reddened	45	52	6	15
Scabby	14	5	58	32
Skin Injured	-	-	5	5

*with a small amount of chopped straw   ses = sesamoidean bone
T4 = 4th tarsal bone

The same workers also examined the bursae by palpation and noted the reaction of the sows. There was a significant positive correlation between palpation of soft tender bursae and reactions by the sow, but not with hard sessile bursae. They concluded from their clinical examinations, that the bursae were painful to the animals in both the early acute stages and later chronic stages of development. However, they then stated that "this pain cannot be clinically assessed". "Defensive" movement could only be established when the bursitis had a spherical shape and was of soft consistency, and this occurred in 30% of cases. They hypothesised that pain might possibly be felt when lying down and there was floor pressure on the bursitis, but not during standing, moving or on palpation. In contrast to Orsi (1967), they noted that X-ray examination of the hock joints of 17 finishing pigs with bursitis, showed no lesions in three, slight arthrosis in five and a medium grade arthrosis in nine. In 12 sows, X-ray examination of the hock joints revealed an arthrosis of medium or high grade (narrowing of articular spaces, exostosis, formation of osteophytes and bony ridges). The clinical finding of curvature of the hock joint was also confirmed in seven cases. It can be concluded that most authors are in accord with regard to the prevalence of other conditions - mainly affecting the integument and mainly considered to have a multi-factorial aetiology associated with intensive husbandry.

Nutrition

In Sweden, Sandstedt and Carlquist (1951) reported that bursitis responded to manganese supplementation and the lesion in Sweden became known as Manganese Deficiency Bursitis! However, this conclusion was not substantiated by other workers in Sweden (Backstrom and Henricson 1966). They concluded that nutrition, food quality and method of feeding had no effect on the development of bursitis.

The latter workers noted that variation in composition of the diet had no effect on the prevalence of bursitis. In other cases a complete change of diet had no effect either.

Gross Pathology

Behrens and Trautwein (1964) described two main types of bursae (1) thin-walled and (2) thick-walled. The former had a pronounced synovial cavity filled with small amounts of yellowish-red fluid, some fibrin floccules and free bodies resembling rice grains. The reddish surface was mostly smooth and moist, bearing some elevations ranging in size from a pin's head to a linseed. Occasionally there were polypoid or tumorous outgrowths of the mucosa. The thick-walled bursae had a cleft-like synovial cavity without fluid contents. The lumen of the cavity was constricted by 'knobbly' and tumour-like outgrowths of the wall, forming niches and sinuses. The inner surface was generally moist and was greyish-white in colour. The thickened wall measured from 0.7 to 1.5 cm in width.

Backstrom & Henricson (1966) noted that the contents of bursae could be serous in character, but in most cases haemorrhagic, and that the lesion was unconnected to tendons, their sheaths or joint cavities. They noted all stages from soft fluctuation to bone-hard protuberances.

Orsi (1967), describing the gross lesion, noted that the skin above the lesion was nearly always thickened. Typically, he found that the lesion was tightly attached at its base but could easily be dissected out because of its sharp margin. Sometimes one or more sub-cavities of various sizes could be found inside the main swelling. These were divided by septae or folds. The cavity walls were either smooth and glistening or were rougher looking because of villus formation. Very occasionally, 'joint-mice-like bodies were observed floating free in the cavity.' Nielsen (1988) studied a number of "enzootic subcutaneous bursae" removed from 26 pigs euthanased for necropsy. Grossly, the subcutaneous swelling consisted of a 2-3 mm thick capsule, distended by yellow-brown sero-haemorrhagic fluid, containing small amounts of fibrin and frequently pieces of necrotic tissue and debris. In more chronic cases, masses of fibrous tissue were present. These subcutaneous fluctuating swellings often contained one or more cavities in which synovial-like fluid was found. Berner *et al* (1990) examined 67 adventitious bursae from sows in detail. They noted that the connective tissue in the superficial and subcutaneous skin in the region of the bursae was a red to dark colour in 40% of cases. In 16% of cases, subcutaneous oedema was noticeable, and in many cases congestion and haemorrhage were observed before the appearance of recognisable bursae. These workers also noted that 35.8% of the 67 cases were spherical in shape, 52.2% were flat and 11.9% were oval. The consistency was soft in 31.3%, solid in 67.2% and bone hard in 1.5% while the walls of the bursae were extremely thick in 9.1%, moderately thick in 18.2% and thin in 31.8% of cases. Internally a cavity was visible in 90.9% of cases, not apparent in 6.1% of cases and divided into two or more parts in 3%. The interior surface of the bursa was smooth in 98.3% of cases and sometimes exhibited white or red bulky protuberances, swollen ridges and tufts. Only 48.3% of bursae with a cavity contained fluid; in 38.3% the fluid was watery and in 8.3% viscous, while 1.7% contained purulent material. Occasionally flake-like granules resembling rice-corn and cucumber seeds were present.

Histopathology

Histological examination of lesions (Backstrom & Henricson, 1966) revealed a 'chronic indurative subcutaneous bursitis'.

Osborne, cited by Penny (1987) concluded that the inner lining of the bursa was a modified synovial sheath.

Behrens and Trautwein (1967) described their histopathological findings in more detail. They noted, that within the synovial cavity of the **thin-walled** bursa, there were some 'knobbly' or elongated protrusions from the wall. There was no endothelial covering. The inner surface was formed of seams of fibrin and a simple layer of fibroblastic cells. Apart from the fibrin deposits, there were also cord-like or isolated fibrin deposits in the superficial layers of the wall. These fibrinous masses stained light greyish-blue or dark blue with Weigert's stain for fibrin. Other homogeneous deposits remained unstained and were regarded as fibrinoid substances. In places the inner surface was fissured, and villus-like fibrin deposits extended into the lumen of the fissure, organized from the base outwards. Both in the fibrin-outgrowths and fibrin-seams there was budding of granulation tissue, composed mainly of fibroblasts, mixed with histiocytes, angioblasts and individual lymphocytes. Underneath was a layer of loose connective tissue containing numerous capillaries or capillary buds. The capillaries were mostly surrounded by a simple layer of histiocytes and fibroblasts, mixed with a few lymphocytes. The peripheral part of the wall was formed of taut connective tissue. The histological picture was that of a chronic fibrinous bursitis.

Thick-walled bursae had a more restricted cavity because of fibrous thickenings of the wall, so that in places the lumen was a mere slit. The lumen was obliterated by massive cones of fibrous connective tissue. On the inner surface there might be remnants of the declining fibrinous inflammation in the form of narrow seams of fibrin or a fibrinoid substance. Alternatively there may be fibrinoid masses in small indentations or niches. Fibrin remnants were demarcated and infiltrated by fibro-blastic granulation tissue, leaving behind islets of infiltrate, composed of fibroblasts, fibrocytes and a few lymphocytes, in the superficial layers of the wall.

Orsi (1967) noted that the surface of the lesion was covered by a thickened, sometimes hyperkeratotic epithelium. Inside, the lining was similar to a synovial membrane. In many cases cellular infiltration of the bursa wall, chiefly around the blood vessels, was common. In some areas a richly angio-fibroblastic tissue could be seen while in others a poorly vascularised tissue composed of thick collagen fibres was observed.

Nielsen (1988) carried out some histopathological studies and noted that the cavity wall showed heavy infiltration with lymphocytes, a few plasma cells and macrophages. In more chronic cases, masses of fibrous tissue were present. Over large areas the fibrinous inflammation had ceased completely, and the inner surface was formed of fibrillar connective tissue. This matured in a peripheral direction and only a few perivascular cell infiltrates were left over from the former bursitis. In numerous cases the formation of fibrous connective tissue (chronic fibrous bursitis) in the bursal wall was so extensive that the structure resembled a fibroma. In places the thickened bursal wall was anchored to the subcutaneous tissue by collagenous bundles of fibres.

Berner *et al* (1990) examined 48 bursae histologically and noted that 18 showed evidence of acute inflammation while 30 exhibited latent chronic bursitis. Massive deposits of fibrin and extensive new granulation tissue and haemorrhagic areas were also seen in acute cases.

Pathogenesis

Penny *et al* (1963) noted that the condition "*on palpation appears to be a bony swelling*". Backstrom and Henricson (1966) noted that "*when fully developed the swelling is a clearly defined fluctuation under the skin that could be up to the size of a hen's egg. All stages from soft fluctuation to bone hard protuberances can be found*". Penny (1987) commented "*I've often wondered why these bursae were sometimes soft and then they fluctuated markedly. I have aspirated fluid and it is like synovial fluid sometimes with clots of fibrin-like material*". Orsi (1967), while discussing the pathogenesis of the condition made the comment "*the type of housing or flooring was not a determining factor since every kind of flooring from straw-bedding, sand, slats and variously laid (flat, edge-up) bricks through to concrete was used on the two investigated farms and the change was observed in the same proportions in groups kept on each surface*". However, he then went on to make the following statement "*the simultaneous presence of several predisposing factors is required for subcutaneous bursae to develop. These include a prominent bone surface, a thin overlying integument, and frequently repeated trauma to the area. These predisposing factors ......consequently repeated trauma to the hock region on lying down or sitting acts as a source of irritation to the thin skin over the selected organism, leading to the development of subcutaneous bursae*". Although he makes it clear that a susceptible animal must be subjected to constant trauma in the hock area, he neither explains why this can happen in a strawbedding system nor did he specify the depth of straw.

Backstrom and Henricson (1966) studied the development of the lesion in a Testing Station and showed how the frequency and severity increased with weight, and consequently age. Prevalence increased from 39% to 58% and severity from 0.66 to 1.4, based on a severity scale of 0 to 5. However, there was no relationship with the rate of growth. From observations on pigs throughout the country they concluded that nutrition, food quality and method of feeding had no effect on the development of the disorder. They did note however, that a herd with the lowest frequency of the disorder had the most plentiful supply of straw-bedding. In another herd, they noticed that bursitis was more common in pigs born in larger litters but no statistical data were supplied. They speculated that this finding had either something to do with competition at the udder, or that piglets born in a large litter had inferior tissue quality. The same authors speculated on the variation in the angle between the lower edge of the hock bone and the metatarsus and came to the conclusion that the Yorkshire breed, because of its basically straighter hocks, would show a greater tendency to bursitis. However, they were in no doubt that the floor surface played the most important role in the development of the condition.

Watson (1987) was of the opinion that modern hybrid pigs with a long back and short legs were more susceptible than breeds such as the Duroc or Chester White, because of the different distribution of weight which induced a "pressure sore".

However Orsi (1967) stated that abnormal or defective leg conformation could not have provoked the change because this occurred with the same frequency in pigs with completely normal conformation and in those with upright, curby or otherwise deformed hocks.

Groch *et al* (1986) concluded that the type of housing especially the floor type, the weight of pig, and inherited susceptibility were the most important factors. Penny *et al* (1963) made the following statement "*.... these lesions which almost certainly result from trauma* .....". Penny *et al* (1972) in a letter to the Veterinary Record concluded that the high incidence of bursitis of hocks and capped hocks, "*give some indication of the present proportion of pigs reared and fattened under husbandry conditions in which little bedding is used*".

Marchant (1984) visited one farm with a bursitis problem and noted that there had been a sharp rise in incidence since the type of flooring was changed from punched metal to metal rods. No bacteria were isolated from bursae examined and it was concluded that there was enough circumstantial evidence to suggest that the aetiology was in part environmental.

Later, Penny (1981) was more forthright in his opinion and stated "........*but it is continuous bruising of this site by a hard floor surface with inadequate bedding, or even more dangerous, a sill to the bedded area or a step down to the dunging area, that precipitates the problem*". Nielsen (1988) noted small subcutaneous swellings in the lateroplantar area of 4-7 weeks old pigs. Slight fluctuation could be felt on palpation and an aspirated fluid was usually of a haemorrhagic nature. The lesions enlarged markedly after the pigs were transferred to finishing accommodation at approximately 12-14 weeks of age. The pigs, in one of the five herds he studied, were bedded on straw over solid concrete, while the others were housed on slatted floors. However, he did not specify the depth of straw. He made no further comments on the cause of these bursae but did note that their prevalence remained unchanged in the herds under study.

Probst *et al* (1990) studied three groups of pigs kept on three different floors from birth (2 groups) and 5 weeks of age (1 group) onwards. The piglets of one group (55 piglets from 5 sows) observed from birth onwards, were housed first in deeply straw-bedded farrowing pens and then in deeply straw-bedded concrete floored pens. The piglets in the other group (40 piglets from 5 sows) were reared in concrete-floored farrowing pens with sparse straw bedding and then housed in partly-slatted (cast iron) pens without bedding to slaughter. The third group (128 weaners) were housed in fully-slatted concrete pens to slaughter at 100 kg. They noted that lateroplantar bursae began to develop on the hock in the first two weeks of life in both groups of suckling piglets. However, the prevalence and severity of bursitis was much higher in the group reared without bedding and the difference was highly significant. They noted that the swellings were painless and were not associated with lameness. There was a sharp rise in prevalence and severity of bursitis in the two groups of weaners housed in pens without bedding. The authors concluded that the development of subcutaneous swellings and bursae was due to mechanical irritation of the skin and subcutaneous connective tissue. Their clinical observations also showed that many of these bursae started early in the suckling period.

Berner *et al* (1990) noted that the number and shape of bursae in sows were influenced by the type of floor the sows were kept on. Cast-iron slats were significantly more likely not only to cause more bursitis but also to cause erosions of the skin over the bursae. They concluded that the length of time the animals were exposed to mechanical trauma influenced the development of bursitis. They also noted that injuries and diseases of the motor joints, leading to long periods of lying down, played a significant role in the development of bursitis. The bony prominences of the calcaneus and tarsal sesamoid bone, in sows in particular, also contributed to the development and severity of the lesion. They noted, from X-ray observations, that the sesamoid bone in sows was more prominent and cuneiform in shape than in finishing pigs. Rate of growth may also play a role in the pathogenesis of the disorder, as Berner *et al* (1990) noted a positive correlation between the rate of growth and the prevalence and severity of bursitis. The latter workers came to the conclusion that adventitious bursitis begins with bleeding in tight connective tissue followed by an exudation of plasma and precipitation of fibrin. As a consequence the threads of collagen are pulled apart. There are no clear indications of their degeneration. The exudation of fibrin leads to the premature formation of an organised tissue, consisting of new granulation tissue near the fibrin and a progressively thickening layer of connective tissue further afield. Other workers have been more specific in their conclusions, blaming sharp-edged concrete slats and total slatted floors, in particular especially where the gaps are too large (Walton and Elliot, 1989). In summary, the weight of evidence which is mostly subjective, would indicate that chronic low grade trauma to the skin over very specific areas, especially bony prominences, contributes most to the development of subcutaneous adventitious bursae.

Bursitis in Other Species

In cattle, tarsal bursitis (also called cellulitis) is a false bursitis characterised by a firm subcutaneous swelling with little effect on joint mobility and in the opinion of Greenough *et al* (1981) is a tissue reaction to repeated low grade irritation or trauma (see Plates 1.1 and 1.2). However, Murphy (1978) stated quite categorically that tarsal cellulitis was not a bursitis but a low grade cellulitis of the subcutaneous tissue. The latter worker also referred to tarsal cellulitis as the corresponding condition of precarpal bursitis. Weaver (1986), however, stated that the terms tarsal cellulitis and tarsal 'bursitis' were synonymous. He made a distinction between precarpal bursitis and "an acquired subcutaneous bursa over the lateral aspect of the hock". The same author concluded that the incidence was high in cattle housed on hard floors with little bedding. Blowey and Weaver (1990) in their colour atlas, described tarsal bursitis as *"lateral swellings over the subcutaneous bursae of both hocks (also called cellulitis)."* This definition infers not only that cellulitis and bursitis are synonymous but that there is a true bursa over the lateral aspect of the hock in cattle. However, the photograph of the cross section of a cow hock in the atlas, shows an adventitious bursa very similar to that seen in the pig (see Plate 3.8). It is quite probable that two distinct pathologies of the lateral area over the hock may occur, namely cellulitis and adventitious bursitis. These conditions may occur separately or together. The swelling associated with cellulitis might be similar to the subcutaneous connective tissue proliferations described in pigs by Probst *et al* (1990). All authors agree that bursitis of the hock in cattle is a painless condition and is not associated with lameness.

Plate 1.1: **A cow with bilateral tarsal bursitis. Note the swelling on the lateroplantar aspect (arrows). Photo. courtesy of R. Blowey**

Plate 1.2: Cross section of cow hock with tarsal bursitis. Note subcutaneous bursa (arrow). Photograph courtesy of R. Blowey.

The development and pathology of adventitious bursitis has probably been studied in greater detail in the dog than any other species excluding man. In the dog, the lesion is usually referred to as a hygroma and according to Johnston (1979), a hygroma is an example of a false or acquired bursa and develops in the following manner. Large dogs exert pressure on many bony prominences when lying down. These prominences include the lateral aspect of the elbow, the tuber calcanei, the greater trochanter of the femur, tubur coxae of the ileum and the tuber ischiadium of the ischium. This repeated pressure leads to an inflammatory response, producing a series of clinical entities. The tissue damage in the vast majority of dogs is mild, severe tissue destruction does not occur and a protective callus develops. In more serious cases, the first clinical lesion to develop is a grade 1 pressure sore. This is a dilatation of blood vessels and inflammatory oedema in the skin and subcutaneous tissues over the bone. When trauma persists, breakdown of tissue occurs leading to haematoma formation in the subcutaneous tissues. Further tissue damage occurs with time and this prevents the absorption of the haematoma. The fluid becomes enclosed in a well delineated sac i.e. a false bursa or hygroma. Occasionally this series of events may be terminated in the early stages by the appearance of an open-pressure sore. Histologically, these false bursae in the dog are characterised by cystic spaces surrounded by walls of dense granulation tissue, the inner layer of which is a layer of flattened fibroblasts. Thus it would seem that adventitious bursae in the dog have similar properties and causes to the condition in the pig. In the horse, examples of adventitious bursitis are capped elbow, capped hock and hygroma of the carpus. (Adams 1974)

In the human, chronic traumatic bursitis of the prepatellar and pretibial bursae are recognised (Turek 1977). Adventitious bursitis is also recognised in the human in both normal and paraplegic patients. "*These bursae will swell up quite large and will have to be drained repeatedly*" (Daniel 1989). However, pressure sores are more common in paraplegic patients and this is probably because they are insensitive to the localised pain. Daniel (1989) hypothesised that adventitious bursae rather than pressure sores arose in the pig because "*these are animals with normal sensation and they would move after a certain period of time, thereby avoiding pressure sore formation. I think that the simple pain mechanism causes the individual to move before tissue ischemia does and that the bursitis is simply a result of this low duration trauma*". Walker (1991) was certain that adventitious bursitis occurred in humans and examples were student's elbow and debatably, housemaid's knee. He was of the opinion that the distinction between a false and true bursa was often difficult and could not always be resolved by microscopic examination since the distinction between a synovial lining and a layer of flattened fibroblasts was very fine.

Pressure sores (similar to those in humans) over the greater femoral trochanter were experimentally produced in pigs by Daniel *et al* (1981). They noted three groups of lesions depending on the pressure applied and length of time pressure was applied.

(a) muscle damage
(b) muscle and deep dermis damage
(c) full-thickness damage extending from bone to skin

They concluded that normal tissue is far more resistant to pressure-induced ischaemia than previously considered and that the pressure duration threshold for the production of pressure sores is lowered dramatically following changes in the soft tissue coverage due to paraplegia, infection or repeated trauma. Adventitious bursitis is not commonly seen in large animals kept in zoos. (Baker 1991, Cunningham 1991) However, Kirkwood (1992) noted what appeared to be a carpal hygroma in an Okapi.

Financial Aspects

No detailed study has been made of the actual costs incurred by the disorder but several authors have referred to some of the financial aspects. Perhaps the work of Marchant (1980) has been most illuminating. He estimated that half the hocks condemned at one abattoir were due to bursitis (3%) and this represented a total weight of 600 lb (273 kg) at that time or £650 per annum. This estimate took no account of loss of aesthetic value or the weight of tissue trimmed. However, a potentially more serious cost was mentioned in relation to the public health risk. A small percentage of bursae were found to harbour coagulase positive staphylococci, and trimming would result in the fluid contaminating the knife and the carcase.

Penny and Hill (1974) noted that a proportion of the meat inspector's time was spent in trimming these lesions because of unsightliness.

Groch *et al* (1986) stated that "*it has been argued that pigs affected by the disorder have daily gains no different from healthy pigs*" therefore implying that there was no economic effect from reduced growth rate, and a similar opinion has been expressed by other authors. (Backstrom & Henricson, 1966, Penny & Hill, 1974, Orsi, 1967).

However, in their discussion, Groch *et al* (1986) concluded that the disorder was important "*for the economies of pig production*" but did not say why. Orsi (1967) noted that the disorder was adversely affecting the "*units finances*" because the sale of "*blemished stock at a fair price was proving difficult*".

Penny (1981) could not put an accurate cost on the condition but mentioned the financial disadvantage to a vendor of breeding stock and the cost of extra trimming at meat inspection.

Backstrom and Henricson (1966) noted that bursitis caused economic problems for both the home and export trades, as buyers would refuse to purchase young stock with bursitis. They also noted that this economic effect was more severe when there was a surplus of pigs on the market.

Shearer (1987) commented that a 'large number' of shanks were lost at meat inspection. It is impossible to quantify the weight of tissue condemned because of bursitis from National Meat Inspection data, as these are included with condemnations for other reasons such as septic arthritis.

The literature reviewed above suggests that bursitis is of major economic importance and has been inadequately studied especially with regard to conditions prevalent in the UK.

This study was intended to determine the extent of the problem and to define it. It was also hoped to use the study to investigate the aetiology.

Each chapter which follows is divided into sections, each of which represents a series of observations or studies on particular aspects of bursitis.

Chapter 2

ABATTOIR SURVEY

Introduction

Although bursitis can be studied in the live animal on the farm, it was thought that the abattoir would be a more suitable place for the collection of a large amount of data and would also be more cost effective.

Objectives

(a) To establish the prevalence and severity of adventitious bursitis of the hock in finished pigs in Scotland.
(b) To study the effect of sex
(c) To study the effect of season
(d) To study the effect of farm size
(e) To study bursal distribution
(f) To study bursae with erosions
(g) To study capped hock
(h) To study foreleg bursae

(a) The prevalence and severity of bursitis

Materials and Methods

Visits were made to five abattoirs in Scotland: two in the South East of Scotland, one in mid Scotland and two in the North East of Scotland. Two of these abattoirs killed pigs exclusively, and all were managed to the standard required by the European Commission for export. Data were collected from 14,046 pigs from 146 farms. The farms were evenly distributed throughout Scotland in relation to the pig density of the various regions. Data collected during the months of October to April were designated winter data, while those collected over the period May to September were referred to as summer data. The following data were collected: slapmark (farm of origin), sex, presence or absence of adventitious bursae of the hock on either leg, the exact location of these bursae (plantar, lateroplantar or medial), the bursal score (estimation of size) and the presence or absence of capped hock. The bursae were subjectively scored from 0 to 4, 4 being the maximum score for any leg. Bursae which had become ulcerated were identified with a score of 5. Examples of scores of 0 to 4 are shown in Plates 2.1 to 2.5.

In addition, samples were occasionally collected for cytological, histopathological and anatomical studies. Bursae on other sites were noted on occasions and some information regarding these was also obtained in special studies. No data were collected from pigs with indistinct slapmarks, or from those with enlargement of the hocks due to arthritis or damage by machinery such as the dehairing machine.

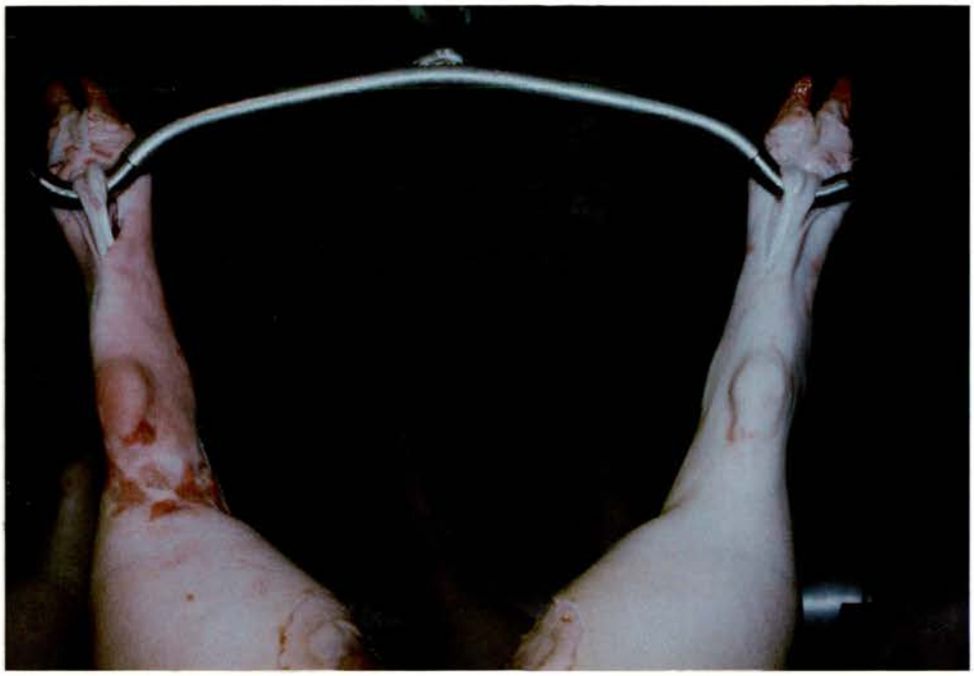


Plate 2.1: A pig with two normal hocks

Plate 2.2: **The left hind leg with bursa (score 1) on the plantar aspect (arrow).**

Plate 2.3: **The right hind leg with a bursa (score 2) on the plantar aspect (arrow).**

Plate 2.4: Both hind legs with bursae (score 3) on the plantar and medial aspects. Arrow 1 - medial Arrow 2 - plantar

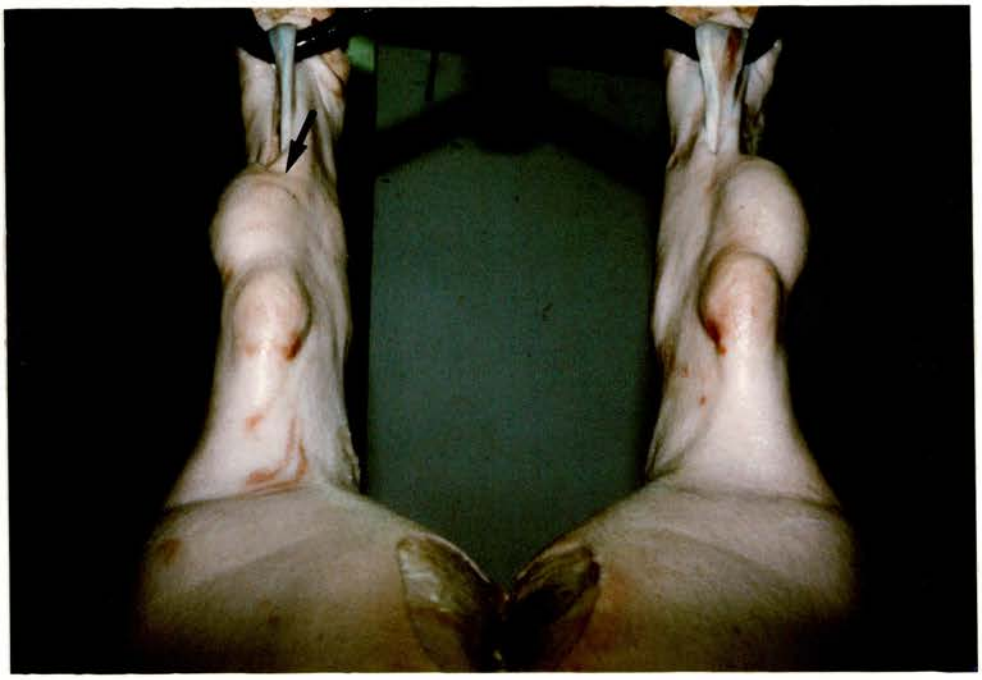


Plate 2.5: Both hind legs with bursae (score 4) on the lateroplantar aspect (arrow).

Statistical Analysis

The data were analysed by using a Genstat Statistical package to produce tabulations and graphical procedures to check trends. Where necessary, regression techniques were applied to model data and estimate standard error. Normally non parametric data (a subjective score) are not analysed by parametric statistical methods. However, in this case, differences between the scores were common and consistent throughout while the large number of pigs examined helped to minimise small errors of subjective judgement. It was considered that the method of measurement equated to that of an interval scale and hence it was appropriate to use parametric methods of statistical analysis.

Before the abattoir survey began, an attempt was made to devise an objective method of assessing the severity of bursitis. Studies were carried out on 40 white hybrid pigs which had been born and reared on deep bedding to 85 kg liveweight. These pigs had normal hocks (i.e. no bursitis). Measurements of mid-hock circumference (HC) and mid metatarsal circumference (TC) were made at regular intervals throughout the pig's life and it was noted that there was a good comparison between the HC/TC ratio for pigs of similar weight. It was established that these crossbred hybrid pigs would be fairly representative of the majority of pigs being slaughtered, apart from a few obvious exceptions such as pure Durocs or other coloured pigs (McKen 1989). It was hypothesised that as the circumference of the hock increased due to the presence of plantar or lateroplantar bursitis, there would be an increase in the HC/TC ratio compared with normal pigs. This method would have identified those farms with a bursitis problem and an objective score could then be assigned to each.

However, at this point in time the review of the literature had not been completed because of translation problems and the knowledge of the possibility of bursae on the medial aspect (Groch et al 1986) was not available. It was common knowledge that bursae might only be encountered on the plantar and lateroplantar aspects of the hock.

Soon after data collection began, it became obvious that bursae on the medial aspect, and at a much lower level than the plantar or lateroplanter bursae, were not uncommon (see Plate 2.4). This complication ruled out the objective method of scoring bursitis and even had a modified measurement technique been used, the speed of the slaughter line would have prevented collection of all the data.

Results

(a) Prevalence and Severity

Data were collected from 14,046 pigs of which 7,350 were males and 6,696 were females. Of the 14,046 pigs examined 12,220 (87%) had evidence of bursitis and the mean score was 1.598 with a range of 0 to 4. Bursitis was noted in the left leg of 11,579 (82.436%) pigs and in the right leg of 11,558 (82.286%) pigs.

Discussion

The prevalence of bursitis in pigs finished in Scotland would appear to be considerably higher than that of their counterparts recorded in England. Penny & Hill (1974) reported an incidence of 73.4% and it is unlikely that this figure has increased very much (Penny 1991). However, more recently Probst et al (1990) reported an incidence of nearly 90% in finished pigs but only 223 pigs were examined. The reasons for the high Scottish figure might include the lesser availability of bedding and the colder climate which tends to lead to higher stocking densities.

Backstrom and Henricson (1966) found there was no difference in the prevalence of bursitis between the left and right leg and similar observations have been made by other workers. (Orsi 1967, Groch et al 1986, Probst et al 1990 and Penny and Hill, 1974).

(b) The Effect of Sex

Materials and Methods

The sex of each pig was noted and if a bursa was present on the hock it was scored in the manner described earlier in this chapter.

Results

Of 7,350 male pigs examined, 87% had bursitis and the mean severity score was 1.615. Of 6,696 female pigs examined, 86% had bursitis and the mean severity score was 1.579. (see Table 2.1 and Appendix 2.1)

Table 2.1: The number of pigs, prevalence of bursitis, sex and mean bursitis score for males and females.

No. of pigs	Sex	Mean bursitis score	Prevalence % ± SE
7350	M	1.615	87 ± 0.58
6696	F	1.579	86 ± 0.60
14046		1.598	

SE = Standard Error

Discussion

The mean bursitis score was higher in males (1.615) compared with females (1.579) and the difference was significant ($p < 0.05$). The difference might be partly explained by the fact that the mean weight of males at slaughter was 90.2 kg while that for females was 85.4 kg. Males tend to have less subcutaneous fat than females and this would also explain the difference to some extent. The prevalence of bursitis in males (87%) was higher than for females (86%), over the year and again this difference was just significant ($p < 0.05$). Other workers have also noted a higher prevalence in males but the difference in each case was not significant. (Backstrom and Henricson, 1966, Orsi, 1967 and Penny and Hill, 1974). It is unlikely that sex has a marked effect on the prevalence of bursitis. The difference in severity of bursitis between males and females has not been examined by other workers.

(c) The Effect of Season

Materials and Methods

The prevalence and severity of bursitis was compared in the pigs examined in the summer group (May-September) with the pigs examined in the winter group (October-April). Although data from the latter group was collected over a period of 7 months compared with the summer group of 5 months, the mean temperature is always markedly lower in Scotland in the winter.

Results

During the winter months, 5,061 male pigs were examined and 58% had bursitis with a mean severity score of 1.663, while of 4,656 female pigs, 87% had bursitis with a mean severity score of 1.641. Of 2,289 male pigs examined during the summer months, 85% had bursitis with a mean severity score of 1.509, while 84% of 2,040 female pigs had bursitis with a mean severity score of 1.438. (see Table 2.2)

Table 2.2: The number of pigs examined, the prevalence of bursitis and the mean bursitis score for males and females in summer and winter

	Sex	No. of Pigs	Mean Bursitis Score	Prevalence of bursitis (%) ± SE
Winter	M	5061	1.663	88 ± 0.65
	F	4656	1.641	87 ± 0.68
Summer	M	2289	1.509	85 ± 0.78
	F	2040	1.438	84 ± 0.84

M = Male SE = Standard error
F = Female

Discussion

The pigs came from 138 farms in the winter and 89 farms in the summer. The prevalence and severity of bursitis was higher in both sexes in winter than in summer. The severity of bursitis in males in winter (1.663) was higher than for males in summer (1.509) and the difference was significant ($p < 0.001$). Likewise the difference in severity of bursitis between females in winter and females in summer (1.641 v. 1.438) was also significant ($p < 0.001$).

The combined mean score for males and females in winter (1.652) was also significantly different ($p < 0.001$) from the combined mean score for males and females in summer (1.476).(see Figure 2.1) The effect of season on the severity of bursitis was not examined by other workers. Although the prevalence of bursitis in males in winter (88%) was higher than for females in winter (87%) the difference was not significant ($p = 0.252$). Likewise, the difference in the prevalence of bursitis between males in summer (85%) and females in summer (84%) was not significant (p = 0.085). The higher prevalence and severity of bursitis in both sexes in winter compared with summer might possibly be explained by stocking density, as it is the tradition in Scotland to keep pigs more densely stocked in the colder months.

(d) The Effect of Farm Size

Materials and Methods

The slap number (farm identification) of each pig was noted and from this information the output of pigs from each farm on a weekly basis was ascertained from each owner. Farms producing less than 25 pigs per week were referred to as small farms, farms producing 25-50 pigs per week were referred to as medium sized farms while those producing more than 50 pigs per week were designated large farms. There were 46, 47 and 57 farms in each category respectively. The relationship between mean bursitis score and farm output was examined. In addition the number of farms producing pigs with mean score categories 0-0.99, 1.00-1.99 and 2.00-2.90 was noted.

Results

Of the 146 farms involved, 31 produced pigs with a mean score of less than 1, 83 farms produced pigs with a mean score of 1 or greater, but less than 2, while the remaining 32 farms produced pigs with a mean bursitis score of 2 or greater, but less than 3. (see Figure 2.2 and Appendix 2.2) The number of farms producing pigs with mean bursitis scores in categories 0 to 0.4 up to 2.5-2.8 in each output group, is shown in Figures 2.3-2.5. In the low output group, only 11 (23.91%) farms produced pigs with a mean bursitis score greater than 1.6. In the medium output group 20 (42.50%) farms produced pigs with a mean bursitis score greater than 1.6, while in the high output group 37 (69.18%) farms produced pigs with a mean bursitis score greater than 1.6.

Discussion

As farm output increased (farm size) there was a clear tendency for more farms to produce pigs with a high bursitis score. This would indicate that as farm size increases, conditions conducive to the development of bursitis are more likely to be present.

Fig 2.1 The mean bursitis score for males & females in winter & summer

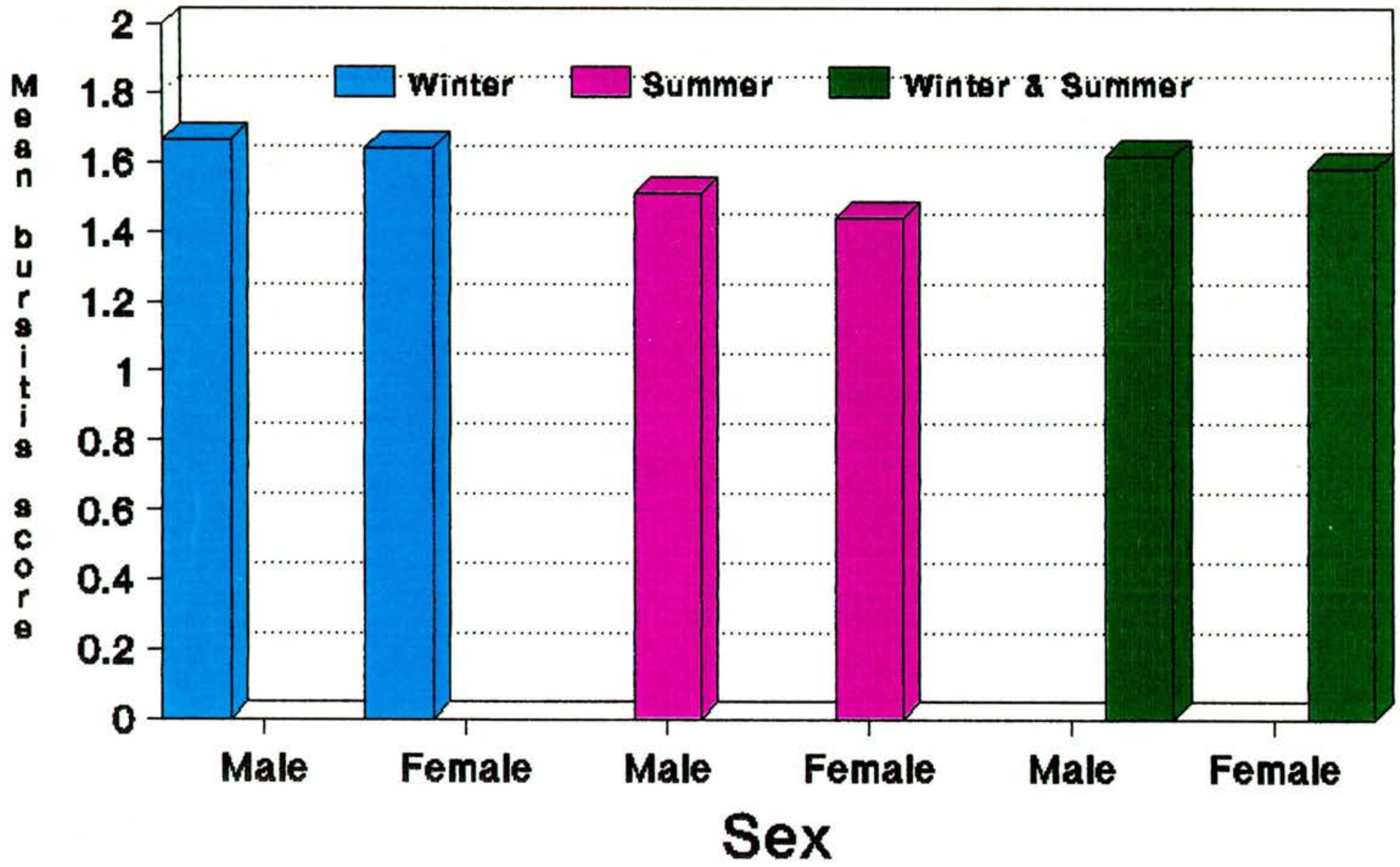


Fig 2.2 The no. of farms in each bursitis scoring category

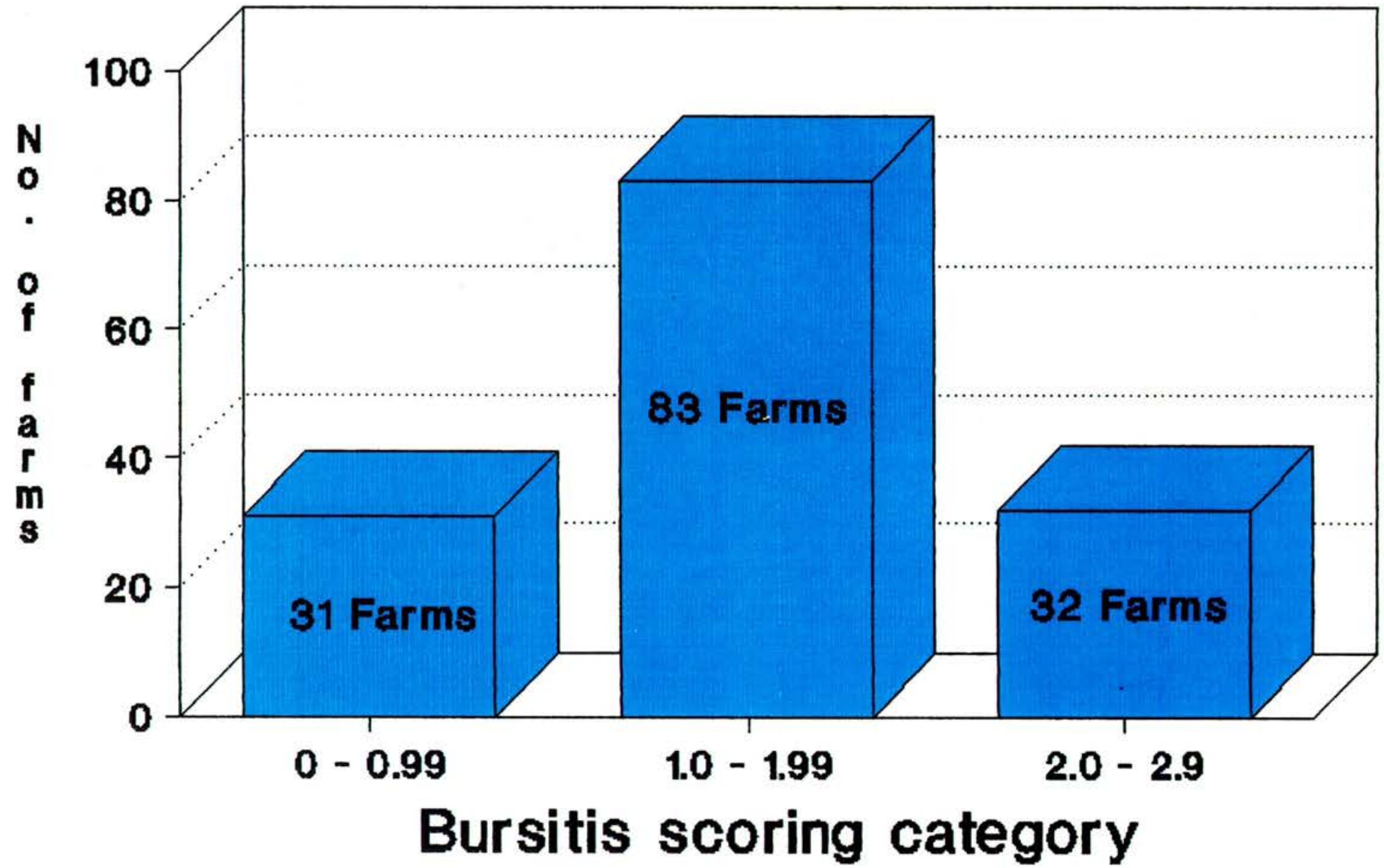


Fig 2·3 The no. of low output farms in each bursitis scoring category

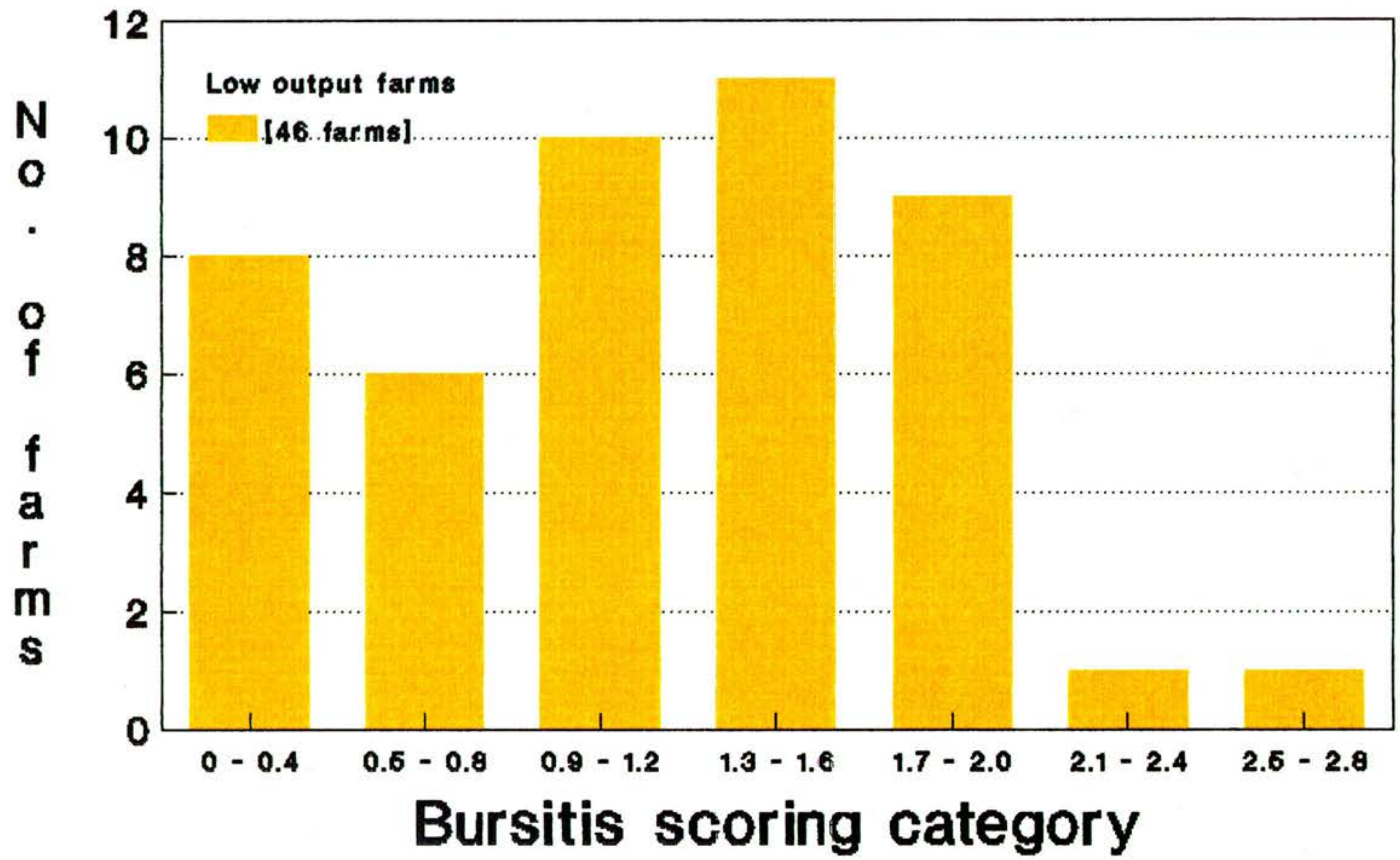


Fig 2·4 The no. of medium output farms in each bursitis scoring category

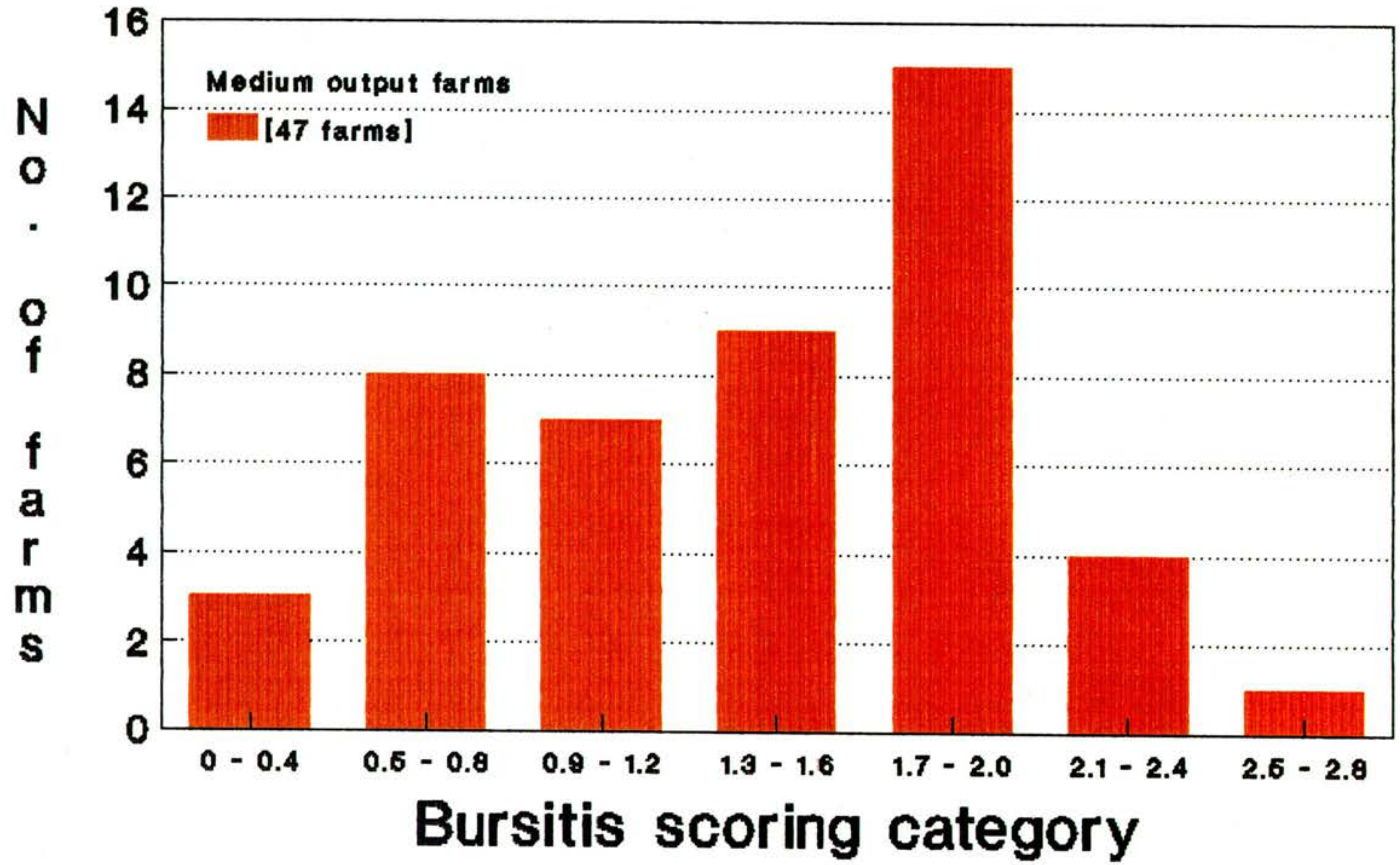
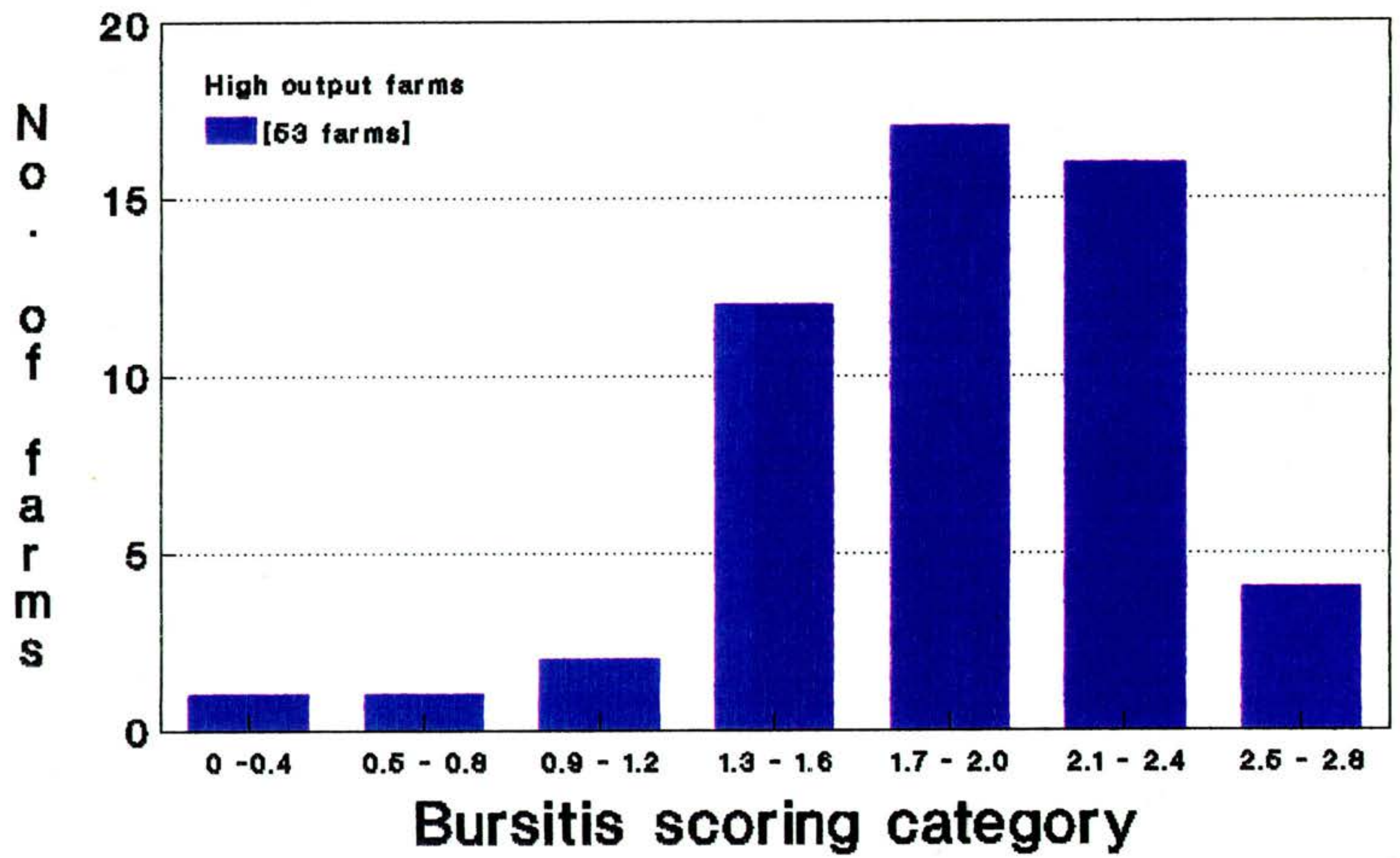


Fig 2·5 The no. of high output farms in each bursitis scoring category



(c) Bursal Distribution

Materials and Methods

When a bursa was present on a hock, its exact location was noted and placed in one of three categories: plantar, lateroplantar or medial. The bursae were scored in the manner already described and their distribution was noted in winter and summer months for both legs.

Results

The number of pigs with plantar, lateroplantar or medial bursitis in either leg during winter and summer is noted in Tables 2.3, 2.4 and 2.5 while the number of pigs with bursitis on these combined locations is shown in Table 2.6 and Figure 2.6. The various permutations of bursae which were found are noted in Table 2.7 and Appendix 2.4.

Table 2.3: The number of pigs with plantar bursitis of the left leg only, right leg only or both legs in summer and winter.

Plantar bursitis	No. of Pigs Affected and (%) of Total Pigs		
	Winter(%)	Summer(%)	Total(%)
Left leg only	638(4.54)	442(3.15)	1080(7.69)
Right leg only	679(4.83)	395(2.8)	1074(7.65)
Both legs	6410(45.64)	2273(16.18)	8683(61.82)
Neither leg	1990(14.17)	1219(8.68)	3209(22.85)
Total	9717(69.18)	4329(30.82)	14046(100.00)

Table 2.4: The number (%) of pigs with lateroplantar bursitis of the left leg, right leg or both legs in summer and winter.

Lateroplantar bursitis	No. of Pigs Affected and (%) of Total Pigs		
	Winter(%)	Summer(%)	Total(%)
Left leg only	466(3.32)	271(1.93)	737(5.25)
Right leg only	427(3.04)	327(2.33)	754(5.37)
Both legs	678(4.83)	394(2.81)	1072(7.63)
Neither leg	8146(58.00)	3337(23.76)	11483(81.75)
Total	**9717(69.18)**	**4329(30.82)**	**14046(100.00)**

Table 2.5: The number (%) of pigs with medial bursitis in the left leg, right leg or both legs in summer and winter

	No. of Pigs Affected and (%) of Total Pigs		
Medial Bursitis	Winter(%)	Summer(%)	Total(%)
Left leg only	222(1.58)	169(1.20)	391(2.78)
Right leg only	293(2.09)	254(1.81)	547(3.89)
Both legs	441(3.14)	229(1.63)	670(4.77)
Neither leg	8761(62.37)	3677(26.18)	12438(88.55)
Total	**9717(69.18)**	**4329(30.82)**	**14046(100.00)**

Table 2.6: The total number (%) of pigs with evidence of bursae on the plantar, lateroplantar or medial aspect in either the left or right leg

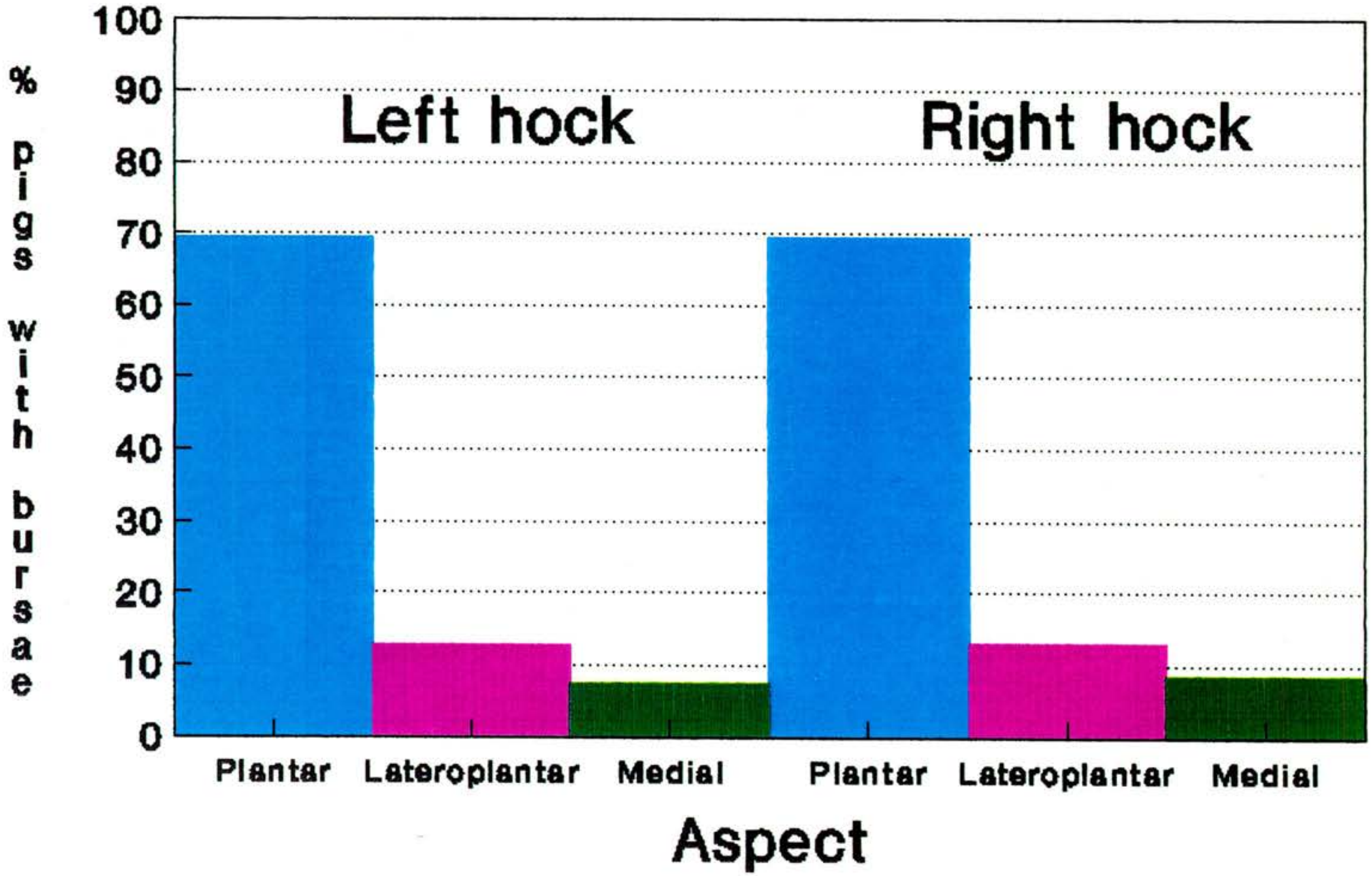
Site	No. of pigs Left Leg (% Total)	No. of pigs Right Leg (% Total)
Plantar	9763 (69.51)	9757 (69.46)
Lateroplantar	1809 (12.88)	1826 (13.0)
Medial	1061 (7.55)	1217 (8.66)
Total	12633 (89.94)	12800 (91.12)

Table 2.7: The various permutations of bursae which occurred in both hind legs

Site	No. of pigs	%	No. of pigs	%
	Left leg		**Right leg**	
P only	8842	(62.95)	8675	(61.76)
LP only	1575	(11.21)	1524	(10.85)
M only	121	(0.86)	135	(0.96)
P + LP + M	13	(0.09)	18	(0.13)
P + LP	101	(0.72)	142	(1.01)
P + M	807	(5.75)	922	(6.56)
M + LP	120	(0.85)	142	(1.01)
No Bursitis	2467	(17.56)	2488	(17.71)
Total	14046	(100.00)	14046	(100.00)

M = medial; P = plantar LP = lateroplantar

Fig 2·6 Overall distribution of bursitis in 14,046 pigs



Discussion

Pigs are nearly eight times more likely to develop plantar bursitis in both legs than in one leg only while the prevalence in winter is almost twice the prevalence in summer. The distribution of plantar bursitis would suggest that when most pigs lie or sit in a fashion which places the plantar aspect of the hock in apposition to the floor, the weight is distributed equally through both hocks.

The most striking difference in the distribution between lateroplantar and plantar bursitis is that when pigs suffer from lateroplantar bursitis they are almost equally likely to do so on the left, right or both legs but again, the prevalence in winter is almost twice the prevalence in summer.

Another big difference related to the frequency of expression, in that only 7.63% of pigs had evidence of lateroplantar bursitis in both legs, whereas almost 62% of pigs had evidence of plantar bursitis in both legs.

The distribution of medial bursitis is very similar to that for lateroplantar bursitis and the frequency of expression is also very close. However, in this case, although the prevalence in winter is more than twice the prevalence in summer when both legs are affected, there is no difference in prevalence when the left or right leg only is affected. It could be concluded that pigs behave in a fashion (sitting or lying behaviour?) which is much more likely to induce plantar bursitis compared with either lateroplantar or medial bursitis. The distribution of the three lesions was almost equal in both legs, again indicating that pigs tend to behave in a fashion which does not discriminate against either leg. Orsi (1967) also noted that both legs were likely to be equally effected while Groch et al (1986) noted that the prevalence of bilateral bursitis increased as the weight increased. However, the data presented by Orsi (1967) showed that lateroplantar bursitis was more prevalent than plantar bursitis by a factor of almost 2:1 (61.4% v 38.6%). This distribution is strikingly different from that noted in the present study and no rational explanation can be offered apart from the possibility that the subjective judegement of placement differed markedly.

Overall the data show a remarkable similarity in distribution of plantar, lateroplantar and medial bursitis between both legs, even taking the permutations into account. Thus 1575

(11.21%) pigs had a lateroplantar bursa on the left leg, but no evidence of a plantar or medial bursa on the same leg, while 1524 pigs were similarly affected on the right leg. It was interesting to note that 121 pigs had evidence of bursitis on the medial aspect only of the left leg. However, an almost similar number of pigs (120) had evidence of medial bursitis and lateroplantar bursitis of the left leg whereas 807 pigs had evidence of medial bursitis and plantar bursitis of the left leg. If bursae arise because of pressure on the skin over a bony prominence it is difficult to explain why pigs should suffer from a combination of medial bursitis and lateroplantar bursitis. Unfortunately, there are no other data with which to compare these findings. Irrespective of the type of combination, the prevalence is remarkably similar in both legs. This would indicate that most pigs have no tendency to favour one side as opposed to the other in relation to behavioural characteristics which induce bursitis when the right environmental conditions are present. It is possible that some recumbent positions, if adopted frequently, would cause bursal lesions on specific areas. When adopting a dog sitting position, as some pigs do just before rising, one hind leg may be held in such a position that the medial aspect of the leg comes into contact with the floor. While in sternal recumbency it is possible to visualise the plantar aspect of the hock coming in contact with the floor, or even the lateroplantar aspect as the pig leans over to one side in particular. The medial bursae are never so large as the plantar or lateroplantar bursae and this may be an expression of the degree of pressure, i.e. the pressure on the medial aspect would be less and this is what one would expect. The presence of a bursa on the medial aspect (see Plate 2.4) was not mentioned by UK workers in their abattoir studies (Penny & Hill, 1974, Marchant 1980), so it was surprising to note that the prevalence could be as high as 7-8% in the present study. The sharp rise in the use of fully slatted floors (especially when made of concrete) might explain the appearance of medial bursae to some extent. It was not until later studies were carried out (Groch et al 1986) that medial bursae in finishing pigs and in sows (Probst 1990) were noted by European workers, so it would appear that these particular bursae represent a fairly recent phenomenon or trend. Bursae on the forelegs likewise appear to be a recent trend and these are discussed in more detail later in this Chapter. Penny (1991) was not aware of these bursae until the early 1980's.

(f) Bursae with Erosions (Score 5)

Materials and Methods

When bursae were presented with erosions of the dermis they were given a score of 5 and the sex of the pig and side affected was noted. The relationship of bursal erosions to farm size (low, medium and high output) was examined.

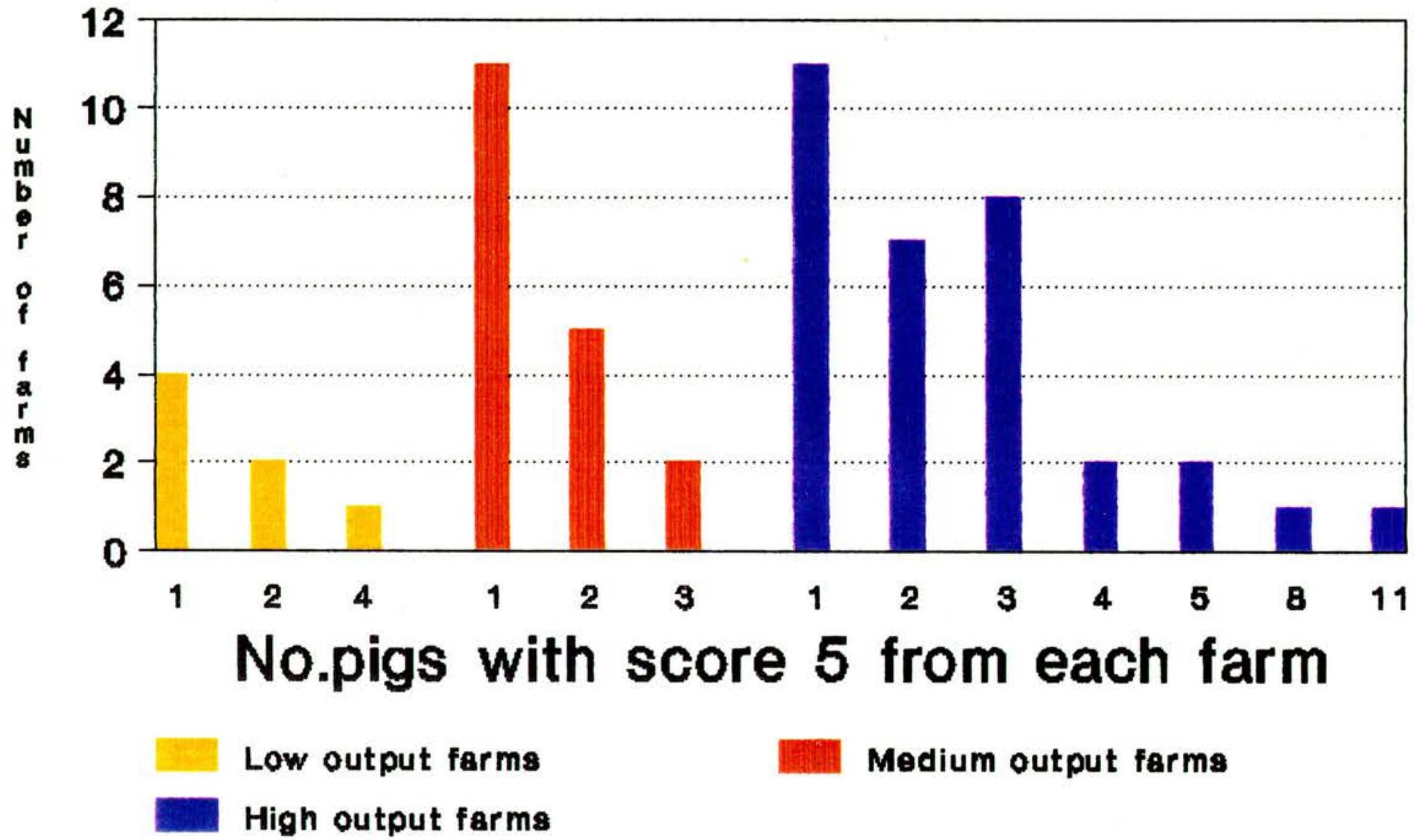
Results

The erosions varied in size from small shallow circular lesions of 4-6 mm in diameter to the kind shown in Plate 2.6. A total of 125 (0.89%) pigs presented with bursal erosions (see Table 2.8 and Appendix 2.5). In the low output group the 12 pigs with bursal erosions came from seven farms, in the medium output farms, the 27 pigs came from 18 farms and in the high output group the 86 pigs came from 32 farms. (see Figure 2.7). The average number of pigs (Score 5) submitted per farm in the low, medium and high output categories was 1.7, 1.5 and 2.6 respectively. There was a significant and positive correlation ($p < 0.01$) between the percentage of pigs with Score 5 and the mean bursitis score per farm. (see Appendix 2.5) No erosions were noted on medial bursae.

Table 2.8: The distribution of farms producing pigs with bursal erosions (score 5) within low, medium and high output farms.

Farm output	No. of farms	No. of pigs	No. of pigs Score 5	% Pigs Score 5
Low	46	2163	12	0.55
Medium	47	4052	27	0.67
High	53	7831	86	1.10
Total	146	14046	125	

Fig 2.7 No. of pigs with bursitis score 5



Discussion

Again, as the farm size increases there is a distinct tendency for the number of pigs with bursal erosions to increase. This would indicate that large farms are more likely to keep pigs in conditions which can lead to bursal erosions. On the other hand it might also reflect the attitude of management on larger farms. As farms become more intensified the ratio of pigs to workers tends to increase (Alexander 1971). Therefore, it is likely that there would be less time to remove affected pigs to hospital accommodation which would allow many of these lesions to heal if caught in the early stages.

In the low output category one-third of the pigs (4) came from one farm. Permission to visit this farm was not given and the reason for the high prevalence with bursal erosions was not established. It could only be established that of the 34 pigs submitted from this farm, 11.6% had bursal erosions. In the medium output group, only two farms submitted 3 pigs with bursal erosions. In the high output category the number of farms sending in several pigs for slaughter with bursal erosions increased markedly. One farm in the high output category submitted 11 such pigs during the study. This was a swill-fed unit with concrete slatted floors. The acidic nature of the swill had eroded the concrete screed exposing a sharp abrasive aggregate. Failure to put affected pigs into bedded hospital accommodation, also contributed to the high prevalence. In the farm which sent in 8 pigs with bursal erosions, the pigs were again finished on concrete slats which had sharp, chipped edges. The floor of the hospital pen on this farm was made of solid concrete and was not bedded.

As the bursae with erosions were nearly always on the lateroplantar aspect they may have arisen because of the way the pigs behaved when lying on abrasive concrete (leg movements etc.). Whatever the cause, all cases could have been avoided by the removal to a bedded pen at the first appearance of the lesion. Many of the farms with high average scores did not submit any pigs meriting a score 5 and when staff from five of these farms were questioned, all were of the opinion that cases arose from time to time but, adequate precautions were taken in good time; this minimised the chance of sending badly affected pigs to the abattoir. In one abattoir, the senior meat inspector always telephoned the owner when a pig with a badly damaged bursa was presented. In the case of the farm which submitted 11 pigs with bursal erosions, the matter was reported to the State Veterinary Service. Many pigs from this farm were being submitted on a regular basis with lameness, swollen joints and damaged skin. Arthritis may also play a role in the development of erosions.

Plate 2.6: **Severe erosion of lateroplantar bursa. (Score 5)**
Note excessive granulation tissue on the plantar aspect.

(g) Capped Hock

Capped hock is the term used to describe a subcutaneous adventitious bursa overlying the point of the hock (tuber olecronae). There is a true bursa (Bursa synovialis tendonis Achilles) underlying the Achilles tendon, which passes over the tuber olecronae.

Materials and Methods

The presence or absence of capped hock was noted during the abattoir survey. There was no attempt to score the lesion but it was not recorded unless it reached the dimensions shown in Plate 2.7. The following data were noted: distribution of the lesion, the severity of other bursitis lesions on the hock, slap mark of pig, farm size, season and sex.

Results

The data relating to the effect of sex is noted in Table 2.9 and Appendix 2.6 while the data relating to the effect of farm size and the relationship between capped hock and severity of bursitis are shown in Tables 2.10 and 2.11 respectively (see also Figure 2.8). The data showing the effect of season are noted in Table 2.12.

Plate 2.7: **Capped Hock: an adventitious bursa overlying the right tuber calcis.**

Table 2.9: The number (%) of males and females with capped hock in either the left leg, right leg or both legs.

Site	Sex and (%) Total Pigs M(%)	F(%)	Total(%)
Left leg	57(0.41)	26(0.19)	83(0.59)
Right leg	32(0.23)	19(0.14)	51(0.36)
Both legs	174(1.24)	87(0.62)	261(1.86)
Neither leg	7087(50.46)	6564(46.73)	1365(97.19)
Total	7350(52.33)	6696(47.67)	14046(100.00)

M = Male F = Female

Table 2.10 The number (%) of pigs with capped hock in either the left leg, right leg or both legs in low, medium or high scoring farms

	Farm Scoring Category			
	Low <1.1	**Medium 1.1-1.7**		**High >1.7**
Capped Hock	**No. of pigs (%)**	**No. of pigs (%)**	**No. of pigs (%)**	**Total (%)**
Left Leg	10(0.07)	22(0.16)	51(0.36)	83(0.59)
Right Leg	3(0.02)	19(0.14)	29(0.21)	51(0.36)
Both Legs	14(0.10)	112(0.80)	135(0.96)	261(1.86)
Neither Leg	2152(15.32)	4678(33.30)	6821(48.56)	13651(97.19)
Total	2179(15.51)	4831(34.39)	7036(50.09)	14046(100.00)

Table 2.11: Mean bursitis scores for those pigs with capped hock of the left leg, right leg or both legs or with neither leg affected.

	Mean Bursitis Score	
	M	F
Left leg	1.079	1.250
Right leg	1.469	1.184
Both legs	0.580	0.644
Neither leg	1.645	1.594

M = Male F = Female

Table 2.12: The number (% of total) of pigs with capped hock of the left leg, right leg or both legs in winter and summer.

Capped Hock	Season & Number of Pigs (% of Totals)					
	Winter	(%)	Summer	(%)	Total	(%)
Left Leg	52	(0.37)	31	(0.22)	83	(0.59)
Right Leg	33	(0.23)	18	(0.13)	51	(0.36)
Both Legs	203	(1.47)	54	(0.38)	261	(1.86)
Neither Leg	9425	(67.10)	4226	(30.09)	13651	(97.19)
Total	9717	(69.18)	4329	(30.82)	14046	(100.00)

Discussion

A total of 263 (3.58%) males out of 7350 submitted had capped hock of the right, left or both legs, while a total of 132 (1.97%) females out of 6696 submitted were similarly affected and the difference between males and females was significant ($p < 0.001$). There are few data in the literature with which to compare these findings. It is difficult to understand why more males than females should be affected by capped hock. Males tend to be heavier than females at slaughter by about 5 kg and this may be part of the explanation. However the lesion can develop early in the pig's life and has been noted in the suckling pig. Penny and Hill (1974) noted that capped hock was more common in males than females over all breed types (12.2% v. 9.9%) and that the condition was more prevalent in white breeds (see Table 2.13). Probst et al (1990) studied three groups of finishing pigs on different floors. They noted capped hock in approximately 12% of 128 pigs (M & F) kept on fully-slatted concrete floors, but no evidence of the same lesion in two other groups kept in pens with solid floors and straw bedding. The effect of sex was not studied by these workers.

The findings of this study would suggest that although the prevalence of bursitis has risen since 1974, the prevalence of capped hock has fallen significantly. However, the difference might also be due to the subjective values used in each study. A sex effect has been reported for other leg conditions, in particular splayleg which is much higher in males (Sabec 1987, Skorries 1975).

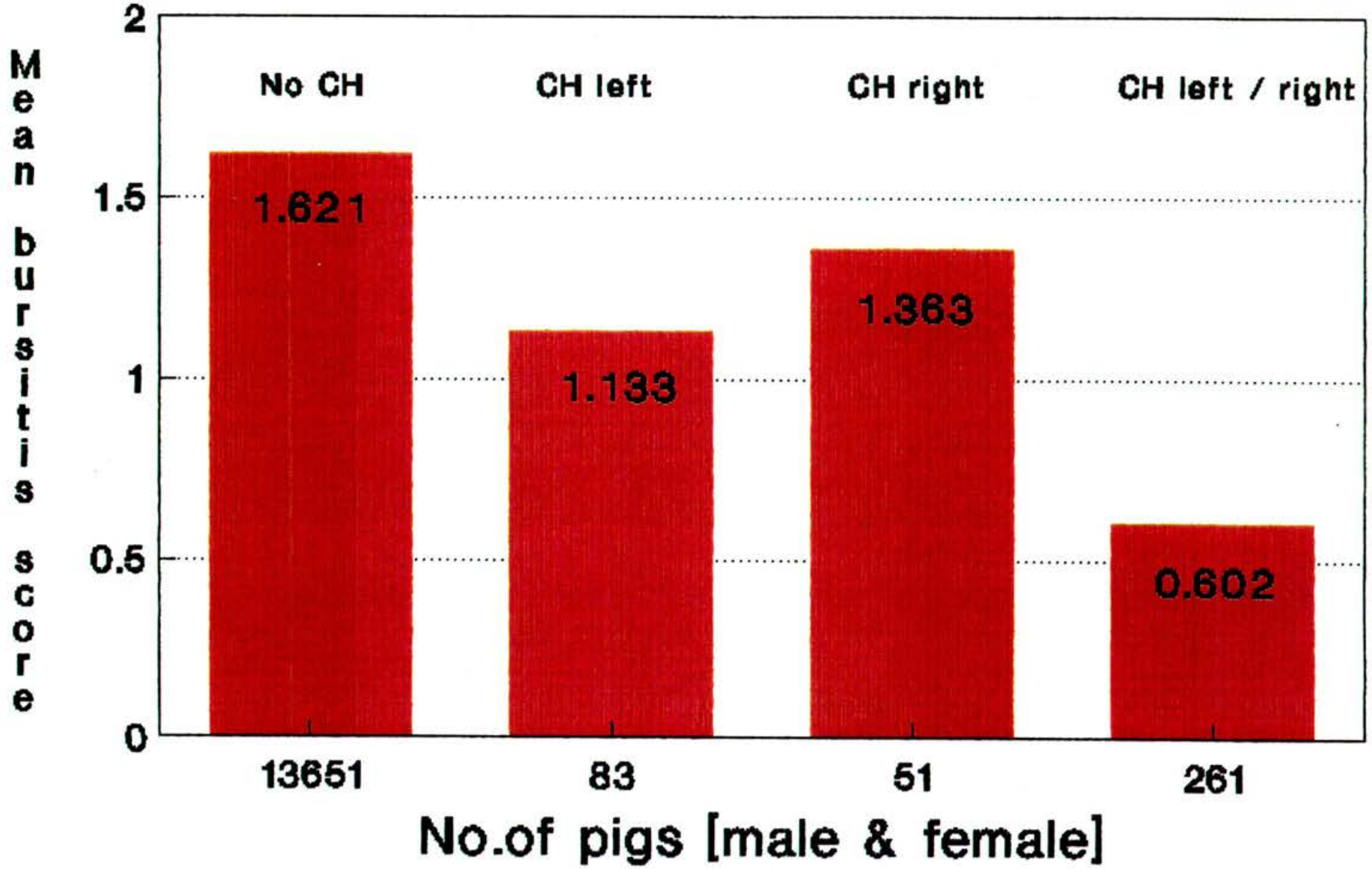
Table 2.13 The prevalence of capped hock in different breed types (Penny & Hill 1974 adapted)

	Males		Females	
Breed type	**No. of pigs**	**% capped hocks**	**No. of pigs**	**% capped hocks**
Prick-eared	3061	8.6	3424	8.1
Lop-eared	2266	18.1	2343	13.4
Saddleback x	363	6.3	354	4.5
Total	5690	12.2	6121	9.9

The data shown in Table 2.10 indicate that capped hock is more likely to be present on the left leg than on the right irrespective of whether they come from farms producing pigs with low, medium or high average bursitis scores and this difference was significant ($p < 0.01$). The distribution of plantar, lateroplantar or medial bursitis of the hock has already been noted and this would suggest that the pig does not discriminate against either leg in a behavioural sense. The possibility of bias in relation to collection of the data must be considered as an explanation. In the two abattoirs where most of the data were collected the pigs moved on the slaughter line from right to left. In this case, the person viewing the pig tends to look to the right when examining the carcase (which is suspended by its hind legs) because the first important step is to read the slap mark which is usually placed on the flank or shoulder. The left hock of the pig will tend to be viewed first and it is possible that the angle of presentation may have led to a bias in the subjective assessment of lesions. Cross (1974) noted that when carcases were partially condemned, condemnations for arthritis were more prevalent on the left hind leg. He concluded that this was due to a combination of two factors: the left hand side is the leading side of the chain and the first side to be inspected and most meat inspectors are right handed so that they tend to open the left stifle joint more frequently than the right. Another reason for the difference between left and right hocks might be the position of the large gut which when well filled, might encourage pigs to lie on the left side. However, there is no indication from behavioural studies that this is the case. (Petherick 1991, Baxter 1991). On the other hand, this hypothesis does not hold true in relation to the distribution of other bursal lesions on the hock. The prevalence of capped hock in the low-scoring category was 1.24%, while in the medium and high-scoring categories the prevalence of capped hock was 3.16% and 3.05% respectively. This would indicate that conditions on larger units are more likely to be conducive to the development of capped hock.

The data shown in Table 2.11 indicate that when capped hock is present on both legs the bursitis score is markedly reduced in the case of both males and females, by a factor of around 37%. The reason for this relationship may be linked directly to the behaviour of affected pigs. It is highly probable that a small number of pigs may sit, or lie, in a way which places more pressure on the point of the hock rather than on other parts of the leg. Although the prevalence of capped hock in the left leg of males is almost twice that of the right leg the mean bursitis score is about 36% higher in the right leg. With regard to females, there was little difference in the prevalence of bursitis between right and left leg and neither was there a difference in mean bursitis scores. There is no rational explanation for the difference between the sexes. However when capped hock was present on both legs in both sexes the bursitis score was reduced by around 37%.

Fig 2.8 Pigs with capped hock and mean bursitis score



Data shown in Table 2.12 indicate that the left leg was more frequently affected than the right in both winter and summer, while the prevalence in both legs in winter was much higher than in summer and the difference was significant ($p < 0.01$). This difference is most unlikely to be due to observation failure and has to be explained in some other way. It is possible that in colder weather pigs tend to huddle more frequently. In Scotland there is often a tendency to increase stocking density in order to maintain diurnal temperature within the upper and lower critical values and this may also play a significant role. The effect of season has not been mentioned by other workers.

(h) Foreleg Bursae

Bursae on the foreleg (see Plate 2.8) were frequently noted while collecting data at the abattoir (The most common sites on the forelegs are described in Chapter 3). It was also noted that when the prevalence and severity of bursitis was high the frequency of foreleg bursae was also high.

Materials and Methods

Two farms which regularly submitted pigs with high bursitis scores were chosen for the study. A note was made of the number and distribution of foreleg bursae in groups of pigs.

Results

The data collected are presented in Table 2.14.

Discussion

Of the pigs from Farm A, 34 (100%) pigs had evidence of bursae on either one or both forelegs while in farm B, 24 (77.4%) pigs were similarly affected. This would indicate that foreleg bursae are more prevalent in pigs with high mean bursitis scores. Probst et al (1990) noted that the prevalence of foreleg bursae was high (82%) when the prevalence of bursitis of the hock was high (90%). None of the pigs with foreleg bursae appeared to be lame. No foreleg bursae were observed in pigs reared on deep straw.

Table 2.14: The number of pigs examined from two farms, the mean bursitis score and the distribution of bursal lesions of the forelegs.

Farm A: **No. of pigs examined = 34**

Average Bursitis Score = 2.152

Hind Legs Left	Hind Legs Right	Fore Legs Left	Fore Legs Right	No. of pigs with bursae
+	+	+	+	31
-	+	+	+	1
+	+	+	-	2
			Total	34

Farm B: **No. of pigs examined = 31**

Average Bursitis Score = 1.490

Hind Legs Left	Hind Legs Right	Fore Legs Left	Fore Legs Right	No. of pigs with bursae
+	+	+	+	18
+	+	-	-	3
+	+	+	-	3
+	+	-	+	1
+	-	+	+	1
-	-	+	-	1
-	-	-	+	1
-	-	-	-	8
			Total	31

+ = bursitis present - = bursitis absent

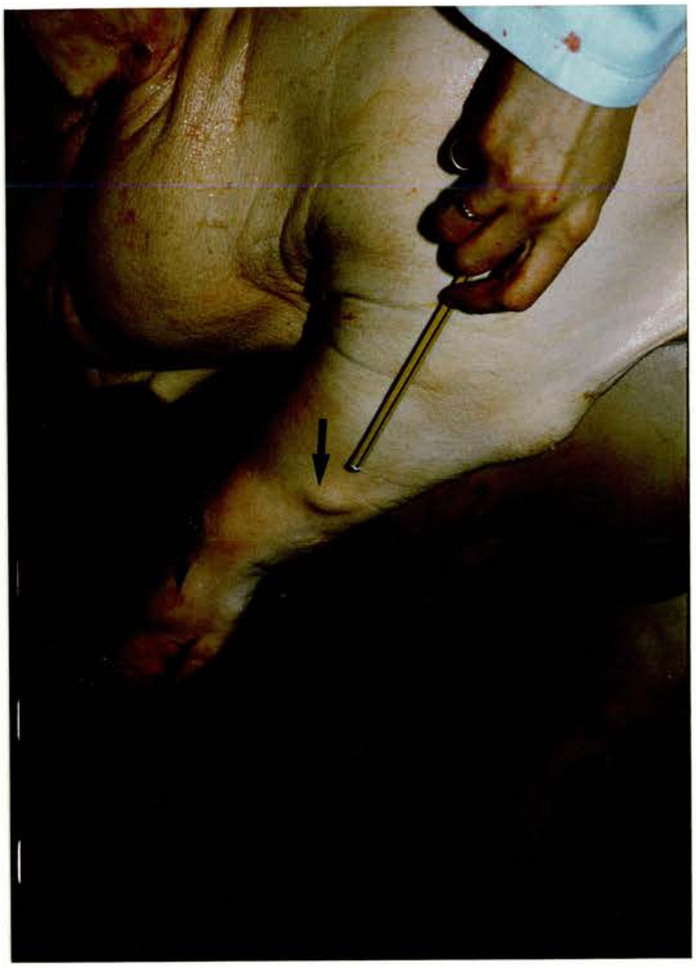


Plate 2.8: **Right foreleg with two bursae (arrows).**

Conclusion

The prevalence and severity of adventitious bursitis of the hock of finished pigs in Scotland was found to be high (87% and 1.598 respectively) and is a considerable increase over figures, recorded in England by Penny and Hill (1974), showing a prevalence in slaughter pigs of 73.4%.

In Scotland, the prevalence and severity of bursitis in males was significantly higher than in females. In winter the prevalence and severity of bursitis in both sexes was also higher than in summer, and again the severity in males in both seasons was higher than in females.

Bursae, when present were nearly always found on both legs. Bursae were noted on the plantar, lateroplantar and medial aspects, but the most common site was the plantar aspect. Pigs submitted from large farms tended to have more bursitis than those submitted from smaller farms and it was thought that this finding may be linked to differences in housing. Pigs with bursal erosions were also likely to be submitted from larger units suggesting that less time and accommodation was available for caring for these pigs.

Capped hock was noted to be more prevalent in male pigs and when capped hock was present bursitis on other parts of the hock was either absent or of low severity indicating a distinct postural trend in some pigs.

Bursae on the forelegs were also noted to be more frequent when the prevalence and severity of hock bursitis was high.

The findings reported in this chapter indicate that more information is required regarding how and why the bursae arise and to what extent housing plays a role. These aspects are examined in Chapters 3 and 4.

Chapter 3

BACTERIOLOGY AND PATHOLOGY

Introduction

Farmers frequently assume that fluctuating swellings must have an infectious cause and this is especially the case in the young pig. There is no doubt that many recently developed bursal lesions are confused with acute septic arthritis and this is why some farmers and stockpersons have associated bursitis with lameness.

At least two meat inspectors assumed that bursae were caused by infection because "they often contained sero sanguineous fluid with clots of pus". These clots of "pus" would probably have been mistaken for clots of fibrin. Nevertheless, in view of the frequency of trimming associated with bursitis, the role of infection, if any, should be clarified as it is not customary for knives to be sterilised after trimming. An infectious component might have a serious public health risk (Marchant, 1980). It was decided to examine the role of infection by culturing bursal fluids in a variety of media.

Objectives

- (a) To establish the role of infection
- (b) To examine the nature of bursal fluids
- (c) To determine anatomical determinants
- (d) To study the gross pathology of bursae
- (e) To study the histopathology of bursae
- (f) To study the role of intercurrent disease

(a) The Role of Infection

Materials and methods

Fluid samples were aspirated from bursae which had developed in suckling pigs, weaner pigs, rearing pigs and finishing pigs. The samples were taken in the following manner. First the overlying skin was cleansed with mild detergent in water and then dried. Ethyl alcohol was then applied and allowed to dry. A sample of fluid was then withdrawn by piercing the bursal sac with a 2.5 cm 19 gauge vacutainer needle attached to a 5 ml vacutainer tube (Becton Dickinson). Samples were then placed in a vacuum flask containing ice.

At the laboratory the fluids were inoculated onto 5% sheep blood agar plates and incubated under oxygen, 10% carbon dioxide, and anaerobically for 48 hours in all cases. In addition, the fluids were inoculated into mycoplasma broth media, and Friis broth plus arginine (Friis 1975) and incubated for seven days.

Organisms isolated were identified by the common procedures used by most commercial support laboratories, including growth characteristics, sugar reactions and biochemical tests.

Results

The number of samples examined, age of pig involved, and the identity of organisms isolated are noted in Table 3.1.

Table 3.1: The number of bursal fluid samples examined, age group of pigs involved and the identity of organisms isolated.

Age Group	Total Examined	No. Neg.	No. Pos.	Identity of Organisms	Comments
Sucklers	46	40	1	Staph. spp.and a Bacillus spp.	Coagulase -ve Contaminant
			1	Staph. spp.	Coagulase -ve
			3	S. viridans	
			1	Staph. aureus	Subcutaneous abscess
Weaners	20	19	1	A. granularum	Contaminant
Growers	15	15	0		
Finishers	18	17	1	Staph. hyicus	A contaminant of skin and vagina
Total	99	91	8		

Staph. spp	= *Staphylococcus species*	Neg.	=	Negative
S. viridans	= *Streptococcus viridans*	Pos.	=	Positive
Staph. aureus	= *Staphylococcus aureus*			
Staph. hyicus	= *Staphylococcus hyicus*			
Achol. granularum	= *Acholeplasma granularum*			

The majority of samples were taken from bursae of the youngest age group. These bursae had only recently developed and therefore one would have expected the best chance of recovering viable organisms, if present. The failure to isolate organisms from long-standing bursae would be less meaningful. Organisms were recovered from bursae of 6 (13.4%) suckling pigs, 1 (5%) weaner and 1 (5.5%) finishing pig. No bursae of growers yielded organisms. In most cases, the growth was sparse.

Discussion

No consistent isolate was obtained and the number of samples yielding organisms was quite small (8.08%). In addition, all the isolates were non-pathogenic with the exception of one, *Staphylococcus aureus*. This isolate was grown from a suckling pig in the College herd, and the identity of the pig was known. This particular piglet was brought to the laboratory 21 hours after the sample was taken, where it was euthanased. The reason for the heavy growth of coagulase positive Staphylococci became obvious when a subcutaneous abscess was found overlying the bursa but separate from it (see Plate 3.1). The vacutainer needle had passed through the abscess before penetrating the bursa and this explained the positive isolation. *Staphylococcus hyicus* is also pathogenic but is a common skin commensal (Taylor, 1990). All samples of fluid were either of a clear nature or serosanguineous. Occasionally, fibrinous debris blocked the aspiration needle, but on no occasion was purulent fluid withdrawn. Marchant (1980) isolated a variety of bacteria (mainly non pathogenic) from bursae collected at the abattoir. However, he noted no difference in the frequency of isolation, irrespective of whether the fluid samples were of a clear, turbid or blood-stained nature. It was concluded that the organisms were opportunist invaders of sites damaged by trauma. Nielsen (1988) isolated *Mycoplasma hyorhinis* from two bursae of weaners but it was not clear if these bursae were unruptured. Bacteria of various kinds have been isolated from a small percentage of bursae by other workers and all have concluded that the isolates were of little or no significance in relation to the causation of bursitis (Behrens and Trautwein 1964, Glawischnig 1965, Backstrom and Henricson 1966, and Probst et al 1990). Histopathological reports by these workers did not indicate an inflammatory reaction typical of bacteria.

(b) Bursal Fluid Examination

Materials and Methods

Fluids were aspirated from 51 bursae representing 16 suckling pigs,. 15 weaners, 10 rearing and 10 finishing pigs. The nature of the fluid was noted, (straw- coloured, blood-stained) and it was subjected to cell counts (RBC and WBC) protein assay, and to cytological examination by light microscopy after staining with Leishman's stain. Protein levels were estimated by subjecting the samples to protein electrophoresis in a Shadow Powerpack*. Individual protein groups were separated on a Boehringer-Mannheim Model 3110 densitometer. Red and white cell counts were carried out electronically in a Coulter Counter.

*Shadow Powerpack - CIBA Corning Universal GEL, CIBA Corning, Bath

Plate 3.1: **Note the subcutaneous abscess (arrow 1) overlying the bursal cavity (arrow 2) on the lateroplantar aspect. The cavity of the abscess is separated from the bursal sac by a thick band of fibrous tissue.**

Results

The values found for total protein, albumin, globulin and red and white cell counts from 15 samples are noted in Table 3.2 and a copy of the computer printout is shown in Figure 3.1. The results of a differential white cell count are noted in Table 3.3. The total protein in these samples varied in range from 14.5 g/l to 39.2 g/l with an average value of 25.06 g/l. The percentage of neutrophils ranged from 17 to 57 with a mean of 27.30% while the mononuclear cells ranged from 43 to 83% with a mean of 72.7%.

Table 3.2: Total protein, albumin and globulin levels and the RBC and WBC counts from bursal fluid

Piglet Age	Sample No.	Nature of Fluid	Total Protein	Alb. g/l	Glob. g/l	RBC[1]	WBC[2]
Sucklers							
2-3 wks	1	BS	19.2	10.5	8.7	1.21	1.2
	2	C	39.2	17.9	21.3	0.55	1.4
	3	C	23.3	12.6	10.7	0.48	0.4
	4	BS	18.7	8.9	9.8	0.71	1.0
	5	C	34.6	16.8	17.8	0.53	3.2
	6	C	19.5	9.7	9.8	0.38	1.5
	7	BS	15.1	5.9	9.2	0.55	2.4
	8	BS	14.5	7.1	7.4	0.55	2.4
	9	BS	28.0	14.0	14.0	1.59	1.6
	10	C	23.3	13.2	10.1	0.28	1.3
Weaners							
	11	BS	29.8	14.2	15.6	0.84	1.6
	12	C	26.4	13.4	13.0	0.41	2.4
	13	BS	21.9	11.7	10.2	0.96	3.5
	14	BS	31.6	15.4	16.2	1.46	2.9
	15	BS	30.8	16.4	14.4	1.56	1.7
Total			375.9	187.7	188.2	12.32	27.6
Average			25.06	12.52	12.54	0.82	1.84

C = clear 1 = $\times 10^{12}/l$

BS = bloodstained 2 = $\times 10^{9}/l$

Discussion

Crimmins and Sikes (1965) quoted a range of 31-54 g/l with an average of 39 g/l for total protein of synovial fluid of normal pigs. This may not be a valid comparison as a bursa does not have a conventional synovial membrane. However, there are no data in the literature regarding the analysis of bursal fluid. The total protein values are almost split equally between albumin and globulin. In arthritic pigs, Crimmins and Sikes (1965) found total protein levels varied from 66 to 99 g/l with an average value of 81 g/l which was more then twice that for normal synovial fluid. The average value for bursal protein was found to be 25.06 g/l in the study and this is approximately 35% less than for normal synovial fluid. Synovial fluid tends to clot and is obviously more viscous than bursal fluid. None of the samples clotted after collection and the viscosity was distinctly less than that of normal joint fluid. The difference between the two fluids might be due to the fact that the former is secreted while the latter is probably more akin to a transudate.

Of the fifteen samples examined in this manner, five were of a clear serous nature while 10 were blood-stained to a greater or lesser extent. It is possible that the needle entered the villus proliferations within the bursae in some instances, and ruptured blood vessels and red blood cells could be identified in these samples. On the whole, the RBC rose as the apparent sanguineous nature of the bursal fluid increased. In smears stained with Leishman, it was noted that fibrin and degenerating cellular debris were common in many samples. The main cellular components consisted of neutrophils, mononuclear cells and degenerating erythrocytes (see Plates 3.2 and 3.3). The majority of the mononuclear cells were lymphocytes, most being small lymphocytes, and the remainder were macrophages and occasional monocytes.

BURSAL FLUID

Patient-Ident. P394/12/90 - 1					
A/G Ratio			Gesamt-Eiweiß / Total Protein 19.2		
Fraktionen	Albumin	α_1-Globulin	α_2-Globulin	β-Globulin	γ-Globulin
		TOTAL GLOBULIN			
Relativ %	54.7	← 45.3		→	
g/l	10.5	← 8.7		→	

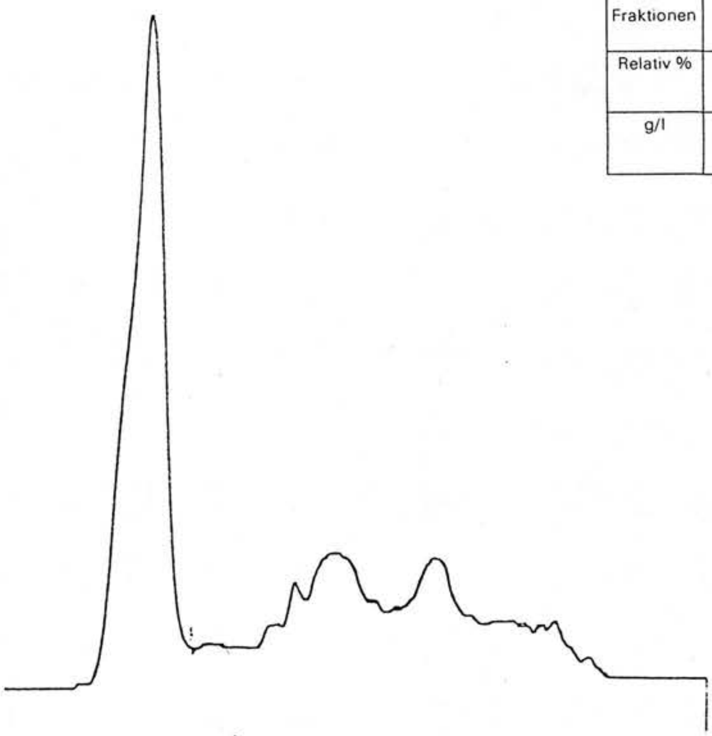


Figure 3.1: Example of computer printout of protein analysis of bursal fluid.

Table 3.3: The % of neutrophils and mononuclear cells in 15 bursal samples

Sample No.	% Neutrophils	% Mononuclear cells
1	20	80
2	17	83
3	36	64
4	27	73
5	27	73
6	33	67
7	29	71
8	24	76
9	57	43
10	18	82
11	23	77
12	25	75
13	26	74
14	28	72
15	19	81
Average	27.30	72.7

Crimmins and Sikes (1965) noted, that in normal synovial fluid neutrophils accounted for 32% of white cells, while mononuclear cells had a value of 66% with synovial cells accounting for the remainder.

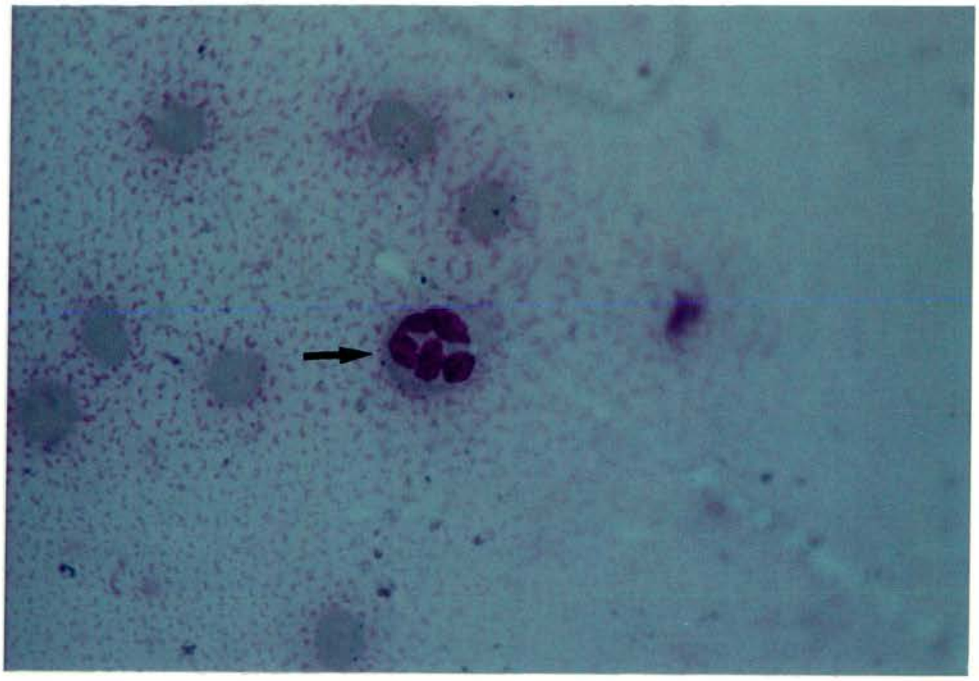


Plate 3.2: Note leucocyte (arrow) and degenerating red blood cells.

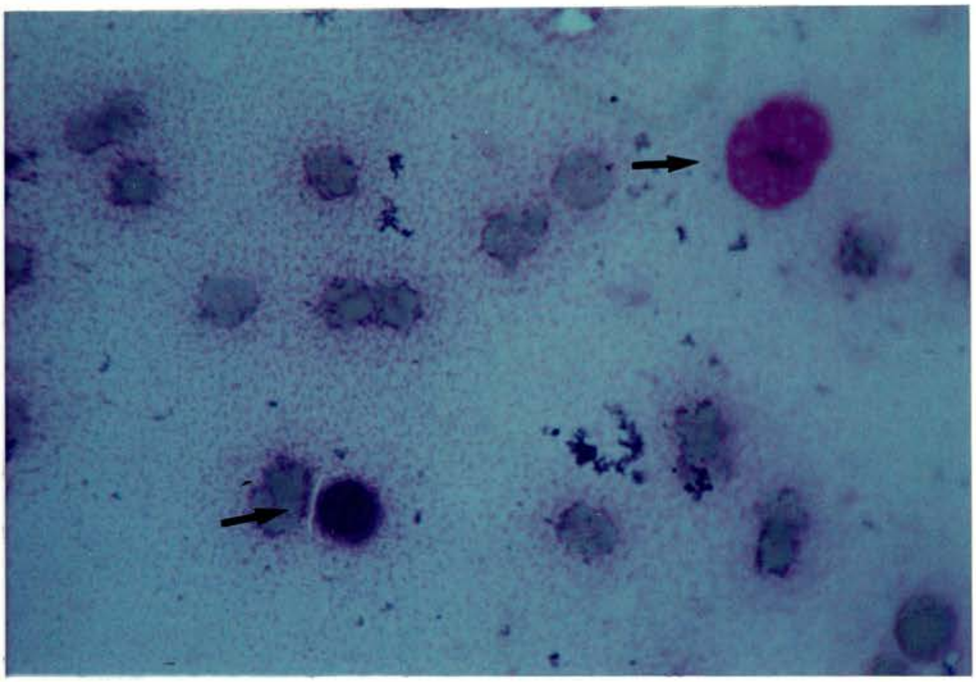


Plate 3.3: Note lymphocyte (arrow 1), degenerating mononuclear cell (arrow 2). The remaining cells are degenerating red blood cells.

(c) Anatomical Determinants

It has already been noted that bursae of the hock have a plantar, lateroplantar or medial distribution. It has also been noted that when capped hock was present, adventitious bursae were less likely to be present elsewhere on the hock, or were smaller. This would suggest that the lying/sitting position of the pig might be a significant factor in dictating where the lesion might present. Pigs are not infrequently seen in a dog sitting position holding both hind legs off the ground by pivoting on the point of the hocks, so it is not surprising that a bursae should develop over the bony prominence (tuber olecronae) of the calcaneus (see Figure 3.2).

Hock Bursae

Materials and Methods

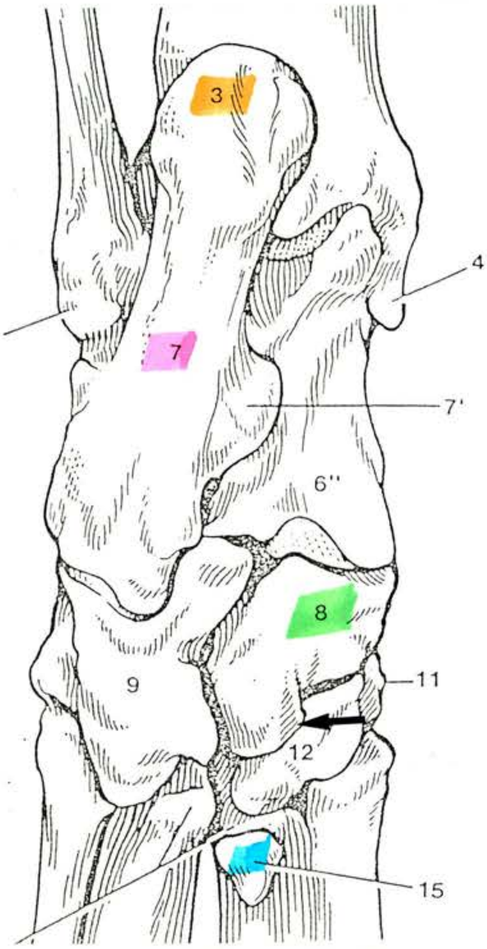
The anatomy of the bony tissues underlying 50 plantar, 50 lateroplantar and 20 medial bursae, was examined in detail by a combination of dissection of fresh specimens after dissolving the soft tissue by heating in 10% KOH or by X-ray examination of hocks collected at the abattoir. Dissection alone proved not only to be difficult and time consuming, but also unrewarding, as the individual bones of the hock were not easy to visualise because of the close apposition of tendons, ligaments and fibrous tissue. Indeed, by the time the bones were properly exposed the original position of the subcutaneous bursae could not be properly identified. Accordingly this method had to be abandoned. X-ray examination was more fruitful (see Plate 3.4). The most rewarding method involved dissolving the soft tissues around the hock as already described, but pinpointing the centre of the bursa with a 2 mm drill bit first and leaving the bit in situ. This was found easiest to accomplish by first freezing the specimen, then clamping the hard tissue in a vice. This prevented the drill bit from slipping, and ensured that it entered the bony tissue through the centre of the bursa (see Plate 3.5).

Results

With regard to plantar bursae, in 50 cases they all lay directly over the plantar surface of the lower calcaneus, as indicated by the drill bit. In 50 cases of lateroplantar bursae, the underlying bony area was the lower lateral aspect of the calcaneus in every case (see Plates 3.6 and 3.7). Medial bursae, however, in all 25 cases lay over the promontory of the central tarsal bone (see Figure 3.2 and plates 3.10 and 3.11).

Discussion

Other workers have suggested that the bursae over the plantar and lateral aspects may overlay the lower calcaneus and the fourth tarsal bone. (Berner *et al*, 1990, Backstrom and Henricson, 1966) There is no doubt that the periphery of some of the larger bursae would impinge on the area of the fourth tarsal. There does not appear to be any particular anatomical landmark on the calcaneus which would induce the formation of a bursa. On the other hand there is little **cushion** between the calcaneus and the skin in this area, and it is quite possible that the pig lies in a manner which directs most of its weight through this small area.



7 = calcaneus
3 = tuber calcis
8 = central tarsal
15 = sesamoid bone

Note the promontory on the central tarsal bone (arrow).

Figure 3.2: Anatomy of the hock - Plantar View

Plate 3.4: Three radiographs of a medial bursa. A screw has been inserted through the centre of the bursa indicating that it lies over the promontory of the central tarsal.

Plate 3.5: Two deep-frozen hocks. Note the drill bit inserted into a plantar bursa in the upper specimen. In the lower specimen the drill bit has been inserted at right angles into a lateroplantar bursa.

Plates 3.6: **Note the drill bit inserted into the lower lateroplantar aspect of the calcaneus.**

Plate 3.7: **Note the drill bit inserted into the lower plantar aspect of the calcaneus.**

Plantar bursae and lateroplantar bursae (score 2 and 3) are easily seen in the cross section of frozen specimens.(see Plates 3.8 and 3.9) In both plates it can be seen that the lateroplantar bursa may consist of two separate sacs, but, on the other hand, may have one sac only.

With regard to medial bursae a casual look at an X-ray, or indeed Figure 3.2, would probably suggest that the sesamoid bone would be the focus of an overlying bursa rather than the promontory of the central tarsal. Berner *et al* (1990) came to the conclusion that medial bursae in sows lay directly over the sesamoid bone. These workers did not find bursae on the medial aspect in finishing pigs and concluded that this was because the sesamoid bone in the latter was a flat elipsoid shape, whereas the sesamoid in sows was of a more pointed triangular nature. However, their observations were based on 27 finishing pigs only. While examining pigs at the abattoir, it was noted that the promontory of the central tarsal was easily palpated in many cases, and, in some pigs, it was bigger than others of comparable weight and size. This might explain, to some extent, why subcutaneous bursae should form over this bony protuberance. However, it does not answer the question as to why this part of the leg, on the medial aspect, should come in contact with the floor. Careful and prolonged observation of many pigs at rest showed that a few individual animals could sit or sometimes lie so that the medial aspect of one leg would come in contact with the floor. It is possible that these individuals, with prominent protuberances on the central tarsal could develop a bursa over this area if they sat or lay in the manner outlined. However, it was not possible to carry out detailed observations on individually identified pigs over a long period. An interesting line of investigation would include the use of a pedo-barograph with a computer linked VDU output, as used in feet studies by Webb and Clark (1981), and time lapse photography.

Foreleg Bursae

Adventitious bursae are not infrequently seen on the foreleg, especially on the lateral aspect above the carpus (see Plate 3.12).

Materials and Methods

The position of these bursae was determined by the freezing/drill technique as described for the hock.

Results

Fifteen bursae were examined in this way and all lay over the bony ridge at the distal end of the ulna (see Plate 3.13). Bursae are often seen over the metacarpal area, frequently bilateral on the dorsal aspect (see Plate 3.14). The bursa (arrow 2) in Plate 3.12 overlay the condyle of the distal articulation of metacarpal IV (see Plate 3.15).

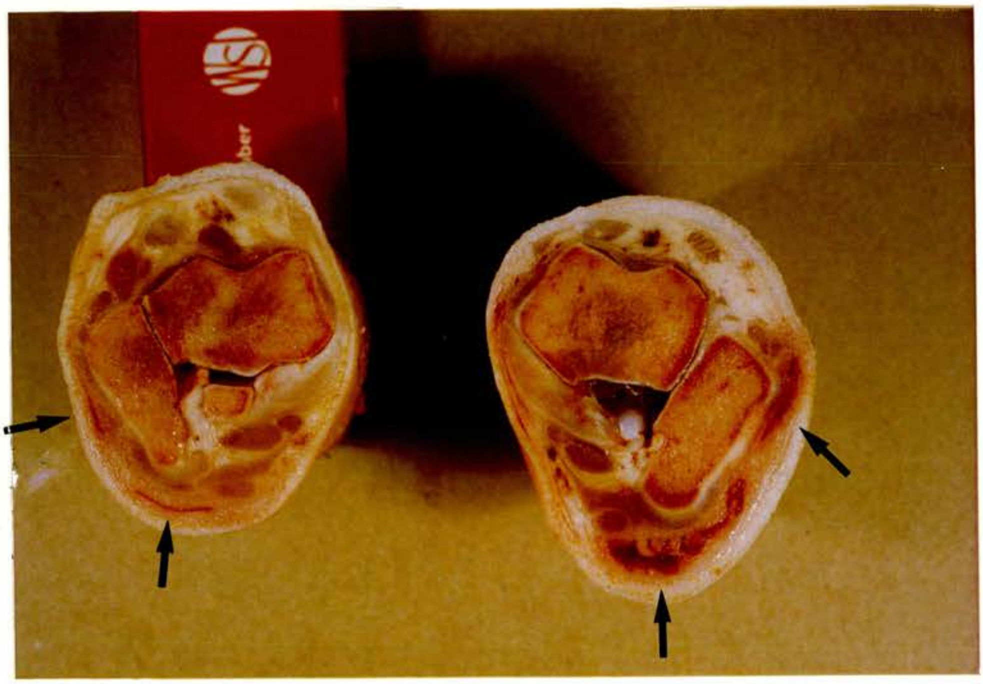


Plate 3.8: **Two hocks with lateroplantar bursae (score 2) on the left (score 3) on the right) (arrows). Note the villous proliferations in the right hand specimen.**

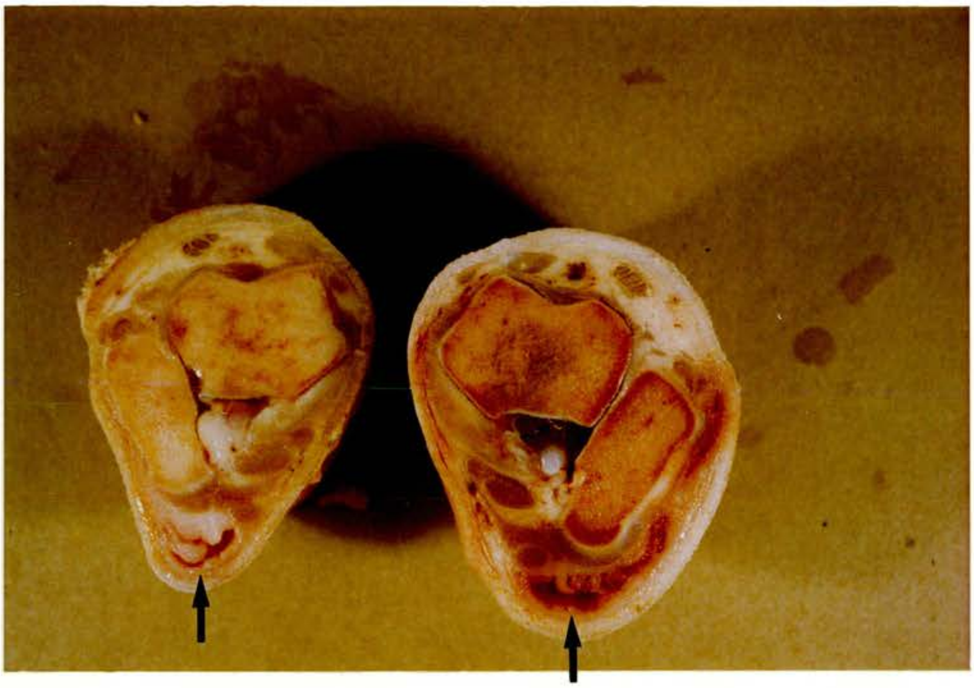


Plate 3.9: **Two hocks with plantar bursitis left (score 2) and lateroplantar bursitis right (score 3) (arrows).**

Plate 3.10: **Transverse section through a bursa on the medial aspect. The bursal sac lies directly over the promontory of the central tarsal (arrow).**

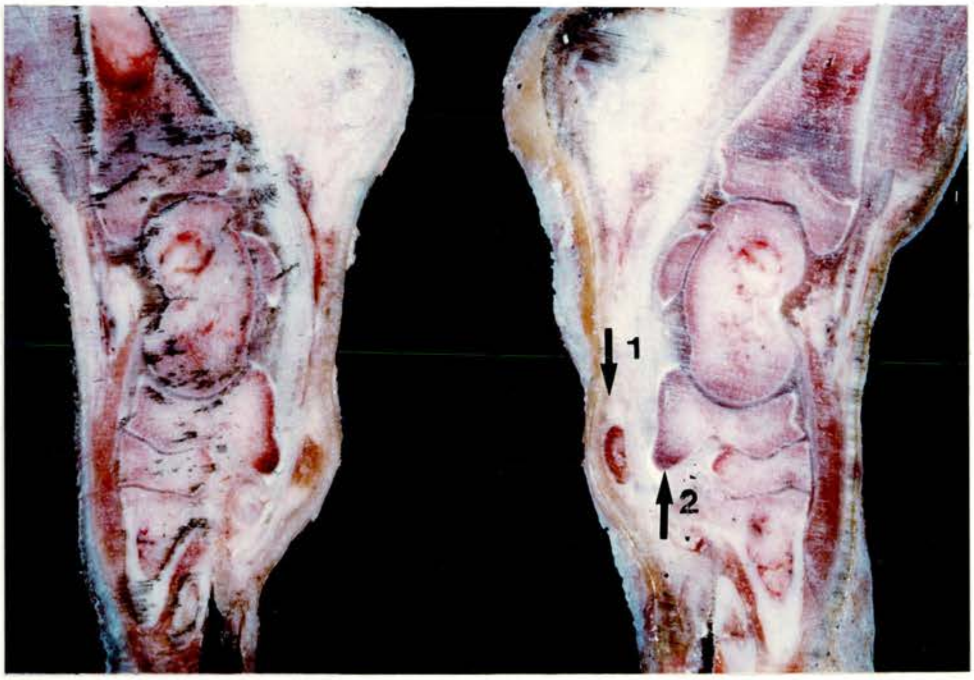


Plate 3.11: **Longitudinal section through a bursa on the medial aspect showing that the bursal sac (arrow 1) lies opposite the promontory of the central tarsal (arrow 2).**

Plate 3.12: **Left foreleg of pig. Note the presence of three bursae (arrows).**

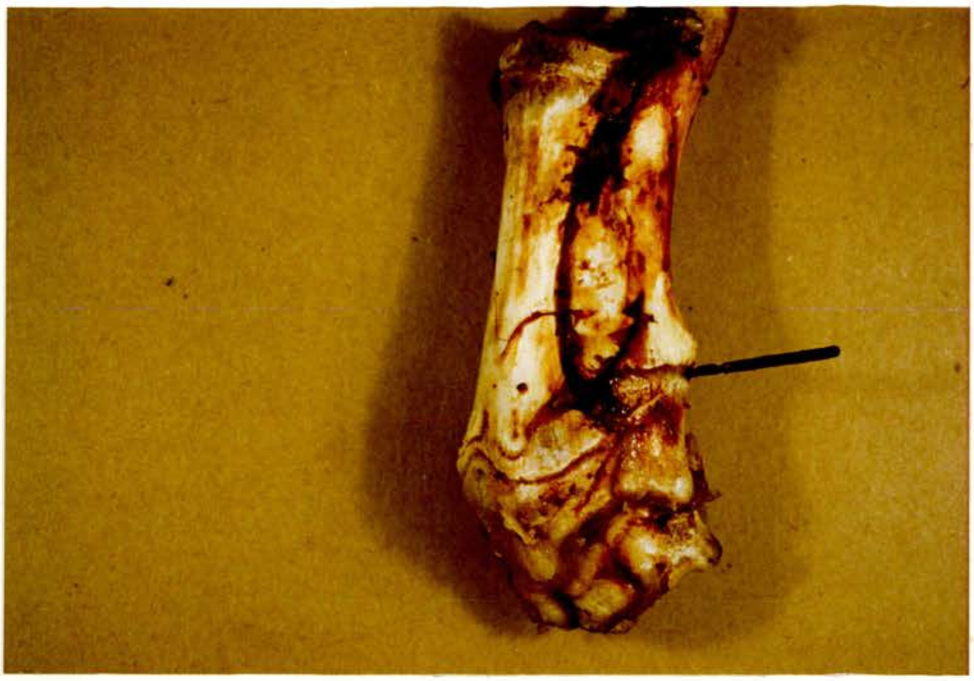


Plate 3.13: Note the drill bit entering near the bony prominence at the lower end of the ulna.

Plate 3.14: Two forelegs with bursae over the dorsal aspect of the joint between upper and middle phalanx IV. The bursae have been incised and show the typical polyp-like growths. (arrow)

Plate 3.15: **Note the drill bit entering the distal articulation of metacarpal IV in each case.**

Discussion

All adventitious bursae described in the pig, including those of the foreleg, have been found subcutaneously immediately over a bone or bony prominence. No adventitious bursae lying deep under muscle or fat have been described. An eloquent anatomical study of the natural occurring bursae of the pig has shown that no subcutaneous bursae exist in normal pigs in the area of the hock in which adventitious bursae appear (Neilsen 1968). Multiple incisions over the hocks of 80 pigs, reared on deep straw from birth to slaughter, failed to demonstrate even the vestige of a bursa.

(d) Gross Pathology

Materials and Methods

Suckling piglets and growing pigs (25-50 kg) were examined on a regular basis (3 times weekly) and bursae were examined grossly as they arose and developed. Bursae were also examined on carcases at the abattoir. In every case all bursae were examined so as to determine their shape, by palpation and in some instances by examination of the internal lining after incision.

Results

Examination of recently formed bursae, in 57 piglets of two to three weeks of age, revealed that in all cases they were of a soft, fluctuating nature apart from six. These bursae were preceded by depilation of the skin overlying the bursa in all cases apart from one. Depilation took place in 98% of pigs, with or without the presence of bursae. However, there was no evidence of bruising or reddening of the skin, or other signs of skin injury prior to formation of the bursa. Incision of 20 recently formed bursae in two to three week old piglets (*in vivo* under local anaesthetic) revealed the wall of the bursae to be thin and the contents to be of a serosanguineous nature in 76% of cases, and serous in the remainder. The inner surface was smooth and glistening in all cases with little evidence of roughening or villus proliferation. However, small clots of fibrin were often abundant (these often blocked the needle in the process of aspiration). The colour of the bursal lining varied from a pale grey to a darkish red, suggestive of acute congestion.

Bursae in young pigs (suckling) varied in size from a large pea to a grape and over 70% were of a flattened conical shape. As pigs became older, the shape of these bursae changed in two ways; the first by flattening and the second by hardening to a greater or lesser extent.

Examination of 388 bursae, from either the plantar, lateroplantar or medial aspect at slaughter, revealed 22 (5.67%) to have a soft consistency due to fluid remaining within the cyst, 214 (55.15%) to have a hard consistency and 152 (39.18%) to have an intermediate consistency. The last mentioned were characterised by hard nodules within a fluid-filled sac, the thickness of which varied considerably.

Bursae were excised from 59 pigs at slaughter. In 55 cases, there was evidence of a cavity, albeit very flattened in many instances. In those bursae which fluctuated on palpation this cavity contained blood-stained fluid in 95% of cases. This high level may be related to the trauma of the dehairing machine. (see Plates 3.16 and 3.17). In seven cases (11.86%) the cavity was divided into two or more sacs of unequal size, by septae or folds. There was a clear tendency for these bursae containing fluid to have much thinner walls than those without fluid. Many of the fluid-filled bursae contained free bodies or **joint mice** about the size of rice grains, indicative of fibrin deposits. The lining of thin-walled bursae (0.15 to 0.4 cm thick) usually had a reddish, smooth, moist surface, with surface elevations which were seed-like in shape or sometimes appeared as polypoid tumour-like extensions. In the thick-walled bursae (0.2-0.8 cm) the lining of the cavity was usually of a paler colour and the lumen was often occluded by pedicles or tumorous-like outgrowths which formed narrow clefts and fissures. The lining of the bursae was nearly always of a glistening, smooth nature with villous proliferation being common. Others appeared to be a mass of dense fibrous tissue without the vestige of a cavity (see Plate 3.18).

No difficulty was found in excising a bursa and at no time did tendons or ligaments appear to be involved. The bursae lay subcutaneously in all cases and there was no evidence of a connection with joints or other lesions apart from those cases in which the surface of the bursa had ulcerated.

Discussion

Berner *et al* (1990) noted 31.3%, 67.2% and 1.5% of bursae were of a soft consistency, hard consistency or bone hard consistency respectively. Similar findings were described by other workers (Berner *et al*, 1990; Backstrom and Henrikson, 1966, Behrens & Trautwein, 1964, Nielsen, 1988, Orsi, 1967 and Penny *et al*, 1963). However, depilation of the skin overlying a developing bursa has not been noted by other workers.

(e) Histopathology

Materials and Methods

Sections were taken from recently formed bursae by biopsy and specimens were also selected from slaughter pigs. All sections were stained H & E.

Results

The histopathological findings varied according to the age and thickness of the bursa. The cavities of younger bursae were lined by plump fibroblast-like cells which resembled synoviocytes in many instances. There was evidence of extensive granulation tissue formation with a well developed blood supply, often in the form of actively proliferating capillaries. Cellular infiltration in the form of lymphocytes, plasma cells, macrophages and occasionally neutrophils were seen. Deeper layers consisted of collagen in which areas of necrosis and foci of haemorrhage were sometimes noted.

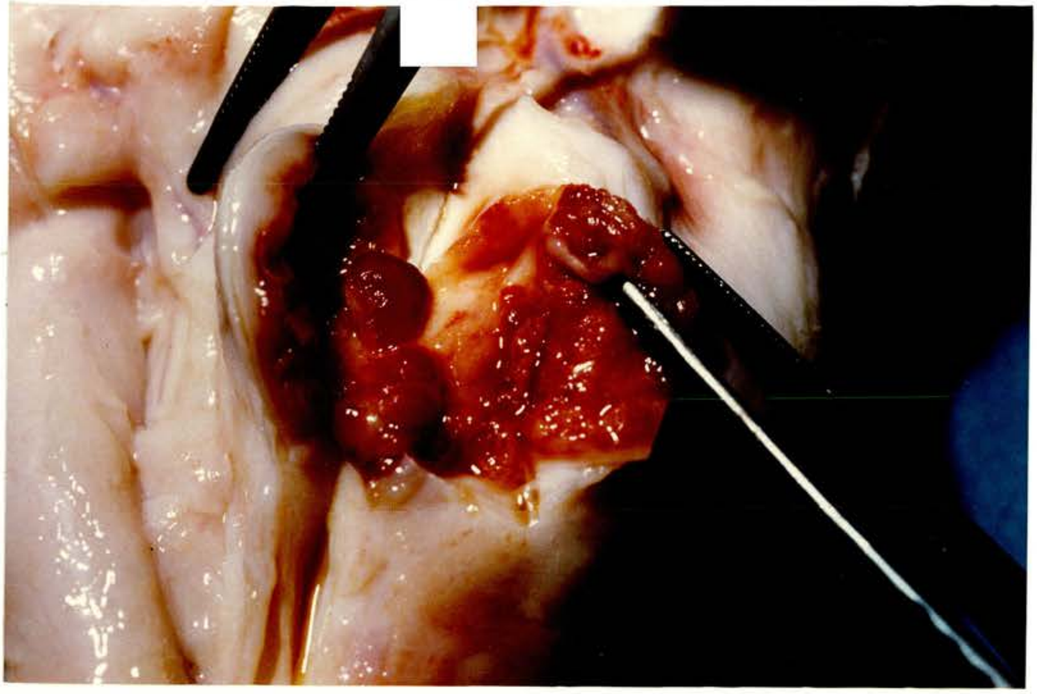


Plate 3.16: Incised lateroplantar bursa. Note the glistening nodular appearance of the lining.

Plate 3.17: Incised plantar bursa containing serosangineous fluid. Note the pea-like nodule of fibrin. The wall of this bursa is quite thick.

Occasionally necrosis of the lining of the bursa was noted. In the more chronic cases, the granulation tissue was more quiescent, the collagen more mature and fibrous, while cellular infiltration was much less marked. Histopathological examination of capped hock bursae and foreleg bursae revealed that their tissue composition was essentially the same as bursae on the hock. Sections of a bursa from a 28-day old piglet are shown in Plates 3.19 to 3.22.

Discussion

The lesions shown in Plates 3.21 suggest that the first stage of bursal formation begins with traumatic damage to subcutaneous lymphatic vessels resulting in the exudation of fibrin and fluid so creating a sac. Further trauma or damage causes breaches in the fibroblast lining, with further leakage of fluid and occasionally red blood cells. This may be noted in Plate 3.22. It has been noted that the lining of adventitious bursae grossly resembles that of synovial membranes which surround joints. Synovial membranes have been studied in some detail and it is generally agreed that the lining is not a true membrane as such, but simply a layer of fibroblasts or fibroblast-like cells (also called synoviocytes, some of which have special properties), interspersed amongst closely laid collagen fibres (Ham, 1957, Coulter, 1962). The synoviocytes of the lining overlap and intertwine and are orientated so that their cytoplasmic processes are arranged towards the luminal surface. In a detailed study of the porcine synovial cell layers by electron microscopy, Roberts *et al* (1969) concluded that there was no basement membrane, the layer varied from 1-3 cells thick and the cells were arranged without connecting structures such as desmosomes but in some areas appeared in a lamellar pattern. Each cell was separated by varying numbers of fibrillar structures with a periodicity resembling collagen. Four types of cells were found within the synovial membrane cell layer:

- (a) mast cells
- (b) cells with well developed endoplasmic reticulum
- (c) cells with numerous vacuoles
- (d) cells with minimal amount of cytoplasmic structures

The last type of cell was thought to be a metabolically inactive cell. The mast cells were probably the source of hyaluronic acid which gives the synovial fluid its viscosity. The authors concluded that the cell activities included protein synthesis, phagocytosis and pinocytosis.

Plate 3.18: Three incised bursae removed from pigs at slaughter. Note the dense fibrous tissue with complete occlusion of the lumen.

Borland *et al* (1962) suggested that there were two cell types in porcine synovial membranes; type A cells were involved in phagocytosis and pinocytosis, while type B cells were concerned with protein synthesis. They also noted that spaces between the lining cells allowed continuity between the joint cavity and intercellular spaces. When synovial spaces become infected, certain distinct changes can be detected in the fluid. It usually becomes turbid, the viscosity decreases while the non-protein mucin increases. In cases of acute infection an increase in the number of neutrophils occurs and erythrocytes may be seen, while glucose levels drop if certain species of bacteria are present. The mucin-clot test is poor. However, after traumatic damage, the fluid remains clear, does not clot on standing and usually gives a good mucin-clot test. Glucose levels remain normal while protein content is rarely elevated. Protein content rarely rises above 4 g/100 ml while the cell content varies between 100-1000/m^3 of which neutrophils may comprise 30% (Doxey, 1971). Therefore, bursae and their fluid-filled contents resemble traumatised synovial sacs in some instances. Mast cells are not apparent in bursal linings and this would explain the difference in viscosity of the fluid. Normally skin overlies loose connective tissue known as areolar tissue, which is mainly composed of fibroblasts, histiocytes, collagen fibres and a gelatinous fluid (tissue fluid). It has been questioned whether free interstitial fluid exists in normal connective tissue on the grounds that:

(1) clear fluid cannot be obtained if the skin is punctured with a needle.

(2) a bleb of fluid injected into the skin retains its shape, being presumably walled off by a jelly-like connective tissue substance, and

(3) Brownian movement of minute particles cannot be observed in the substratum of normal connective tissue.

The fact is however, that free fluid quickly accumulates in tissues subjected to pressure, friction and vascular stasis (Le Gros Clark, 1958). When fibroblasts in tissue culture are subjected to regional tension, the cells exposed to the tensile force multiply more rapidly and orientate themselves in parallel lines in the direction of stress (Weiss, 1929). This phenomenon has also been observed in the subcutaneous tissues of adult animals when exposed to mechanical stimulation. The absence of a basement membrane and secretory apparatus raises the question of how bursae arise. It is likely that mechanical stress due to pressure, will probably result in a number of reactions including proliferation of fibroblasts with deposition of collagen, occlusion and subsequent distension of lymphatics and a low grade inflammatory response. The end result is the formation of a fluid-filled sac or bursa which may contain blood cells which escape easily through the cellular spaces from damaged capillaries. As time passes, the bursa gradually becomes larger due to accumulation of dense fibrous tissue and fluid. According to Arey (1958) bursae arise in later foetal months as clefts in the connective tissue between the skin and the fascias and/or tendons. Backstrom and Henricson (1966) were also of the opinion that subcutaneous bursae were preformed in the embryo but that opinion is disputed by Bollwahn (1980) and Plonait and Bickhardt (1988). Tombol and Vizkeleti (1962) state: *"subtendinous bursae are present in the human foetus at 4 months of age, but subcutaneous bursae are absent during foetal life".* Irrespective of whether subcutaneous bursae are preformed or not, the large adventitious bursae which develop over bony prominences in the leg of the pig will only do so in relation to constant pressure, or low grade chronic trauma. The histopathological findings would indicate that lymphatics in the loose subcutaneous areolar tissue become occluded, distended and distorted.

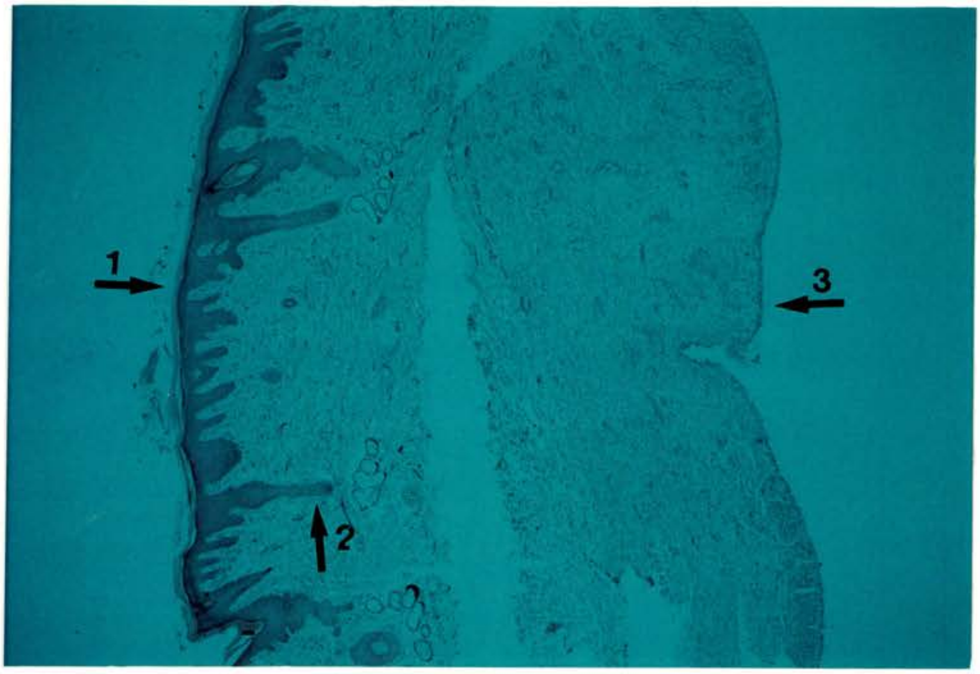


Plate 3.19: **Low power view of skin, subcutaneous tissue and bursal lining in an early case of bursitis. The epidermis shows mild hypertrophy with hyperkeratosis (arrow 1) and elongated rete pegs (arrow 2). The space in the middle is artefactual and is surrounded by loose connective tissue. The bursal lining (arrow 3) is on the lower edge of the picture.**

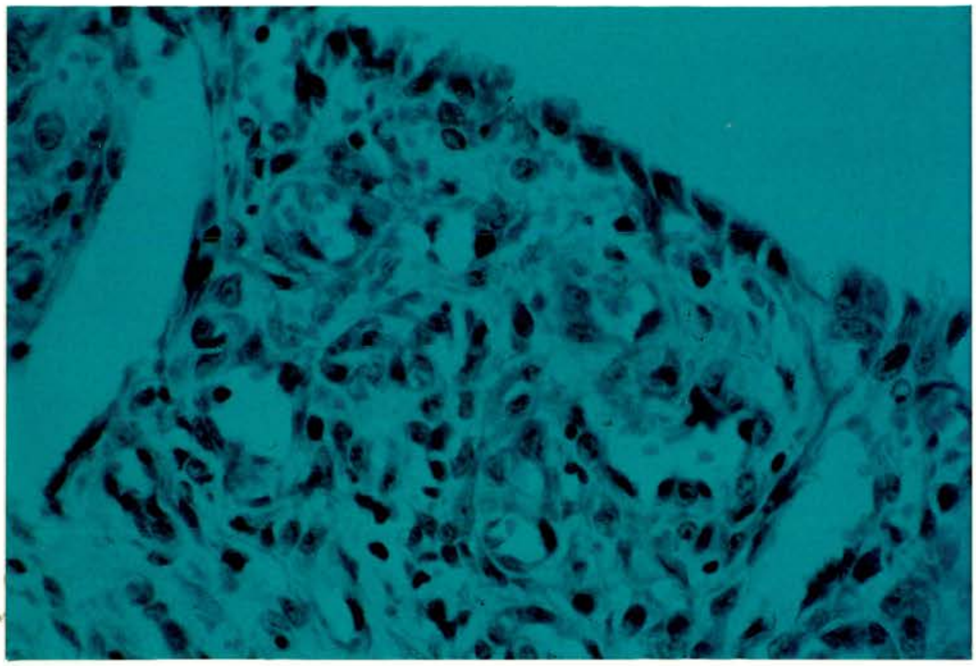


Plate 3.20: High power view of bursal lining and adjoining tissue. The lining is composed of fusiform fibroblast-like cells. Beneath the bursal lining there are numerous capillaries and a loose arrangement of fibroblasts.

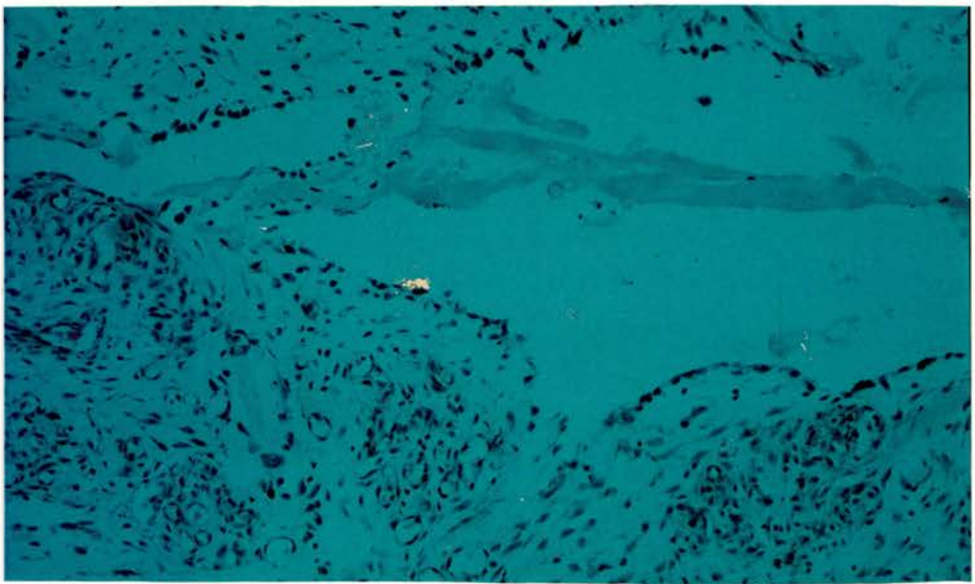


Plate 3.21: This plate shows a distended lymphatic vessel in an early case of bursitis. Degenerating strands of fibrin may be seen in the lumen.

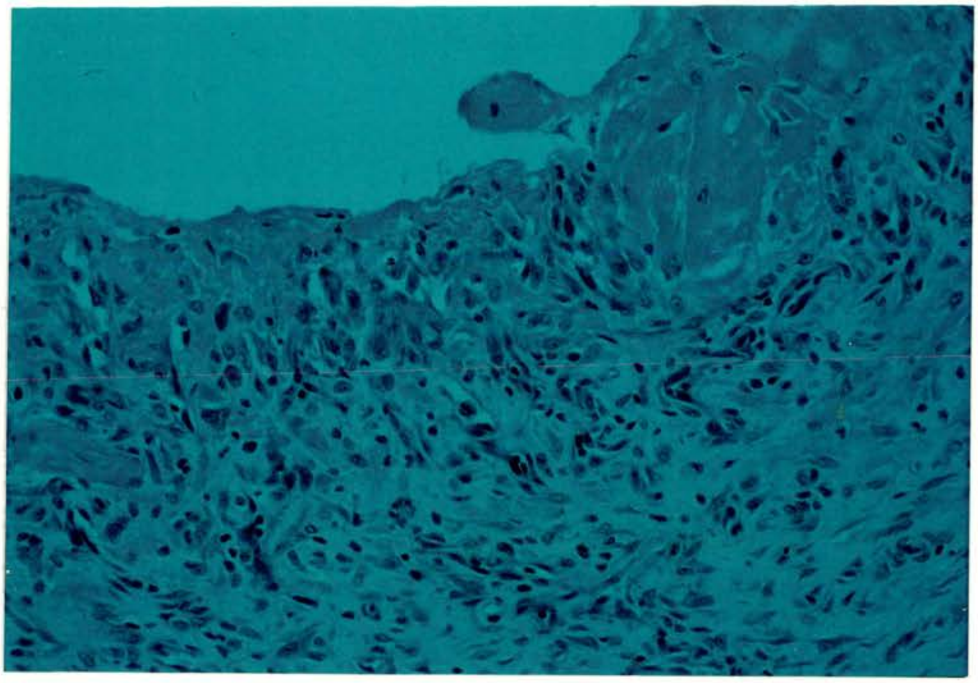


Plate 3.22: **An early bursa showing a central cavity lined by a degenerating/ necrotic wall with no distinct epithelial lining. Fibrin and cell debris are present in the cavity. The remaining tissue is characterised by active fibroplasia and infiltration with mononuclear cells and neutrophils.**

Fibrin is deposited in the lumen, while fibroblasts proliferate and lay down collagen fibres in the direction of stress.

(f) Intercurrent Disease

Introduction

The role of intercurrent disease, in particular disorders of the feet and legs, has not been specifically examined in relation to bursitis by other workers. Leg weakness is a poorly defined condition which has been noted by workers in most countries rearing pigs intensively. However, no relationship between leg weakness and bursitis was mentioned in studies by several workers (Thurley, 1967 and Grondalen, 1974).

In an abattoir study, Penny et al (1963) noted a high prevalence of bursitis in pigs which had a high prevalence of footrot. The relationship between the two conditions was not specifically examined however.

Materials and Methods

In order to study the relationship between bursitis and arthritis, it was decided to examine pigs with arthritis from farms with a high prevalence of bursitis. Data were collected from 175 pigs from 20 farms. These pigs had been detained at the slaughterhouse because of arthritis.

Results

The average bursitis score and the number of pigs detained from each farm was noted and the results are shown in Table 3.4

Table 3.4: The number of pigs from each farm, the mean bursitis score and the number of pigs detained for arthritis.

Farm No.	No. of Pigs	Mean Bursitis Score	No. of Pigs detained
1	76	0.54	2
2	54	0.76	1
3	51	2.49	0
4	96	1.41	0
5	45	0.57	0
6	62	1.14	1
7	125	1.76	2
8	87	1.42	0
9	141	0.94	3
10	91	0.99	1
11	111	1.98	2
12	122	2.47	3
13	98	2.21	0
14	114	1.43	0
15	62	1.74	0
16	46	0.98	1
17	87	1.86	1
18	49	2.47	2
19	131	1.62	0
20	102	0.32	0
Total	1750	1.455	19

Of the 20 farms submitting pigs, 11 had pigs detained for arthritis of one or both hind legs while 9 farms had no pigs detained. The average bursitis score of the pigs detained for arthritis was 1.44 while the average bursitis score of those without was 1.47 and the difference was not significant ($p > 0.05$). (see Table 3.5)

Table 3.5: The number of pigs and mean bursitis score of these with or without arthritis of the hind legs.

	Arthritis Present	Arthritis Absent
No. of Farms	11	9
No. of Pigs	964	786
Mean Bursitis	1.44	1.47

A maximum of three pigs was detained from two farms on two occasions. The average bursitis score in pigs from one farm was 0. 94 while in the other it was 2.47.

Discussion

These results indicate that conditions which give rise to bursitis do not necessarily cause arthritis. However, the claws of the pigs with arthritis were not examined, as these were missing or partly destroyed due to the plotting, dehairing process, and it is possible that the arthritis may have been linked to claw injury. This aspect is examined in more detail in Chapter 7. A pig with arthritis of the hind legs however, might be inclined to lie for longer periods than unaffected pigs on hard floors, and such animals might develop a higher degree of bursitis than their unaffected contemporaries. Penny and Muirhead (1986) stated that *"any weakness of the legs or other locomotor upset making getting up and down difficult are further predisposing factors."*

During the farm trials particular attention was paid to the gait of pigs which developed bursitis and also those which remained normal. Bursitis of the hock was not related to lameness unless there was evidence of arthritis as well. This conclusion was reached by other workers. (Bollwahn, 1980, Behrens and Trautwein, 1964, Glawischnig, 1965 and Plonait, 1988) Frequently pigs with bursitis had a weaving gait, or sometimes almost crossed legs as they walked, but this sort of locomotion was seen with the same frequency in contemporaries without bursitis. Likewise, the presence of curby hocks, cow hocks or straight hocks was equally distributed between pigs with and without bursitis. Orsi (1967) was of the same opinion. The latter author noted degenerative joint changes in 14 out of 17 pigs with bursitis examined by X-ray but he did not examine pigs without bursitis from the same age group. Berner et al (1990) examined 17 finishing pigs with bursitis by X-ray and found that 14 had varying degrees of arthrosis. No joints from normal pigs were examined. At the abattoir, thousands of pigs were inspected in the lairage and again there was no correlation between lameness and bursitis of the hock. However, as the prevalence of bursitis increased in some groups, the prevalence of lame pigs also increased, but there was no difference in the number of lame pigs between those with and without bursitis of the hock. The presence of other lesions such as skin abrasions, tail biting, ear biting, flank biting and bursae on other sites was more frequently noted when the prevalence and severity of bursitis was high.

When the prevalence of bursitis is high, the presence of other lesions, mainly of the integument, has been noted by other workers. (Backstrom and Henricson 1966, Doman 1966, Penny and Hill 1974, Groch et al 1986, Berner et al 1990 and Probst et al 1990).

Nielsen (1988) described outbreaks of enzootic bursi]tis in which about 10% of finished pigs over a 4-month period were lost (deaths, culls or condemnations) due to enlarged bursae becoming damaged and infected, resulting in generalised pyogenic infections.

Backstrom and Henricson (1966) noted a higher prevalence of bursitis in pigs with pneumonic lesions compared with those without. This observation was made in 190 pigs.

Conclusions

It was concluded that infection did not play a role in the development of adventitious bursae. Bursal fluid was noted to be less viscous than synovial fluid, contained less protein and did not clot after aspiration. Samples were either serous in nature or blood stained. The main cellular components were neutrophils mononuclear cells and red cells. Adventitious bursae arose on plantar or lateroplantar aspects of the calcaneus or over the promontory of the central tarsal bone. Grossly, young bursae had thin walls and a smooth glistening lining. As they aged, bursae tended to become harder due to the accumulation of fibrous tissue and contained less fluid. After histopathological examination of recently formed bursae it was concluded that trauma to lymphatics in the connective tissue led to the exudation of fluid and fibrin which became walled off by fibroblasts, creating a sac.

There did not appear to be a relationship between bursitis and arthritis.

As infection did not appear to be implicated in the development of bursae it was decided to examine the effect of housing and this is reported in Chapter 4.

Chapter 4

FARM HOUSING SURVEY

Introduction

Analyses of the data collected during the abattoir survey showed that the prevalence and severity of bursitis from each farm was almost uniformly constant over time. It was also noted that there was a large variation in prevalence and severity between farms. If the physical environment does play a significant role in the development of adventitious bursitis, it can be hypothesised that the floor might play the most significant role as this is the part of the physical environment which is in almost constant contact with the feet and legs. Management might also play a role and in this case stocking density could be a determinant. It was decided to examine both these aspects.

Influence of Floors

Objective

To assess the relationship between housing (i.e. the physical environment) and the severity of bursitis, especially with regard to floor type.

Materials and Methods

Thirty farms which consistently produced pigs with either high, medium or low average bursitis scores were identified and visited. Details of the floor surface in each housing section were collected and the time spent by the pigs on each floor was also estimated, as well as other factors such as the presence of a sill or step from one part of the pen to another. Because the abattoir survey and the housing survey were not and could not be carried out at the same time, the housing observations made on the farm did not relate precisely to the pigs scored at the abattoir. Nevertheless, the number of batches from each farm, and the time over which they were examined at the abattoir, would have significantly reduced the effect of a few pigs being reared for a short time outwith the normal accommodation. In addition, the farm housing survey was only carried out on farms which had not made any significant changes to the pens within the housing system in the previous 15 months.

Many laboratory methods of testing the hardness (or softness) of materials have been described and include the Brinell Test, the Rockwell Test and the Vickers Test (Nilsson, 1988). The hardness of floors for livestock (cattle in particular) has been measured using steel balls under point load (Bring, 1968, Loken, 1978, Boxberger and Lasson, 1974 and Wander, 1970).

In order to show a reading these tests require penetration of the floor surface by the ball. By extrapolation from the data given by Nilsson (1988) none of the floors examined in this study would have shown a point penetration reading with a force equivalent to the weight of a 100 kg pig, apart from two floors, namely, deep straw and deep sawdust which would have showed readings in the very soft category.

On this basis, the floors were placed into three categories: hard, intermediate and soft. All floors, apart from the deep sawdust and deep straw floors, were placed in the hard category, except for those hard floors with a covering of bedding (which varied greatly) which were placed in the intermediate category.

The time spent by the pigs on each floor category was assessed according to the history given by the owner and also assuming that pigs spend approximately 80% of time lying down (Baxter, 1984).

Statistical Analysis

The data were analysed by regression analysis, with bursitis score and floor score as treatment factor and replicate. In order to analyse the effect of floor category on bursitis, a value of 1, 0 or -1 was given to hard, intermediate and soft floors respectively. The floor score was calculated as follows:

e.g.	Pigs spend	60% of time on a hard floor	(H)
		15% of time on a intermediate floor	(I)
		25% of time on a soft floor	(S)

$$\text{Floor Score:} = \frac{2(H) + 1(I) + 0(S) - 100}{100}$$

$$= \frac{120 + 15 + 0 - 100}{100}$$

$$\text{Floor Score} = 0.35$$

The statistical analyses are shown in Appendix 4.1.

Results

The distribution of farms according to bursitis score is noted in Table 4.1 and Figure 4.1, while the various types of floor in each floor category are noted in Table 4.2.

Table 4.1: Number of Farms, Average Bursitis score and Category into which they were placed

	Low Scoring	Medium Scoring	High Scoring
Number of units	10	10	10
Average score range	0 - 0.99	1 - 1.49	1.5 - 2.75
Average bursitis score	0.452	1.281	2.092

Bursae graded 0-4

Fig 4.1 The mean bursitis score per farm

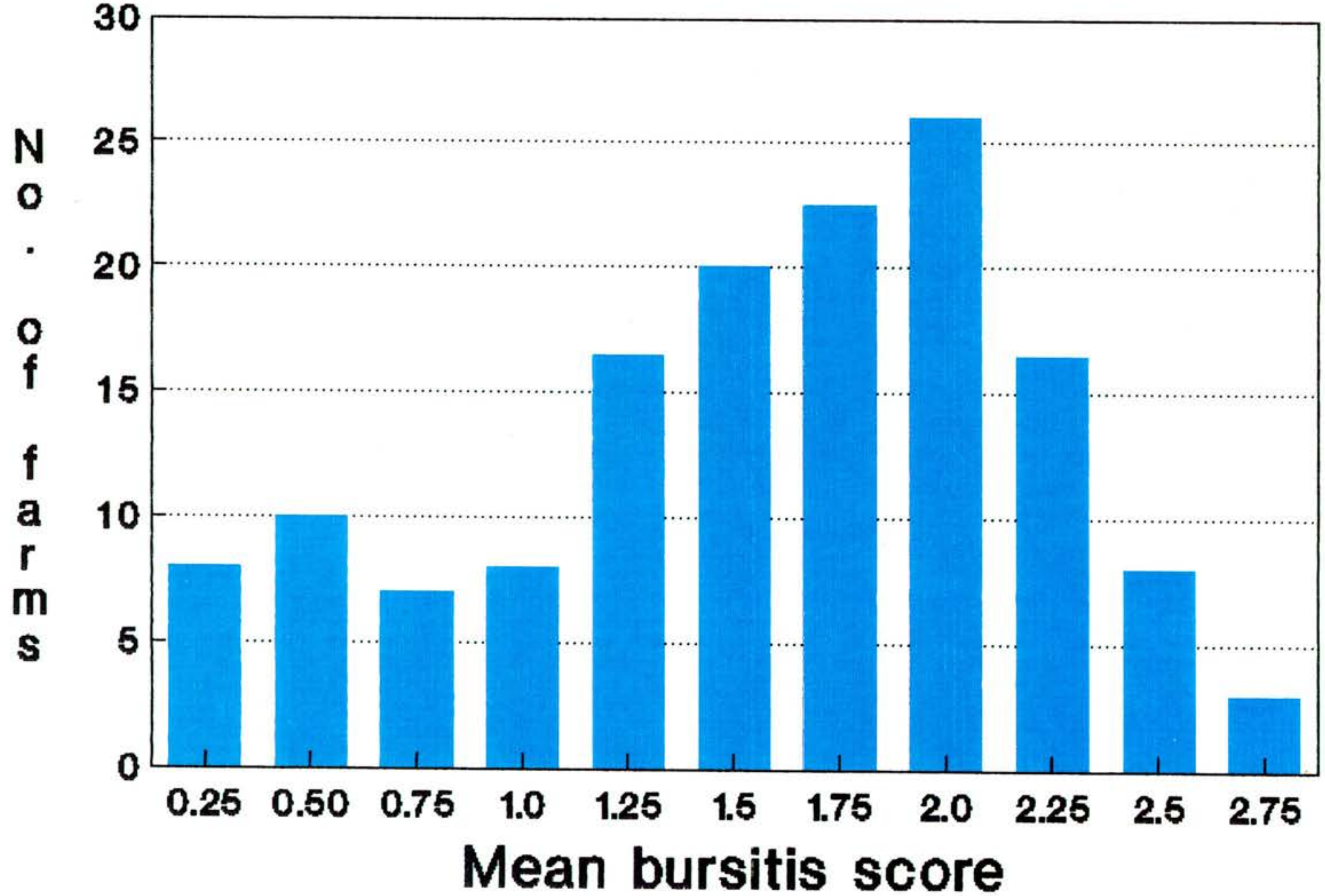


Table 4.2: The type of floor, the category into which placed and the abbreviation.

Category	Type of Floor	Abbreviation
Hard	Woven wire	WW
	Solid concrete	SC
	Concrete slats	CS
	Round metal rods	RMR
	Flat metal rods	FMR
	Expanded metal	EM
	Punched metal	PM
	Plastic slats	PS
	Cast iron slats	CIS
	Wooden Floor	WF
	or combinations of above, e.g.	
	solid concrete/round metal rods	SC/RMR
Intermediate	Any combination of above plus bedding	
	Round metal rods/solid concrete and sawdust	RMR/SC/S
	Concrete slatted area/strawed concrete	CS/ST/SC
Soft	Deep straw	ST
	Deep sawdust	S

A description of each type of housing in each unit is given in each of the Appendices 4.2 - 4.4 The data collected were summarised and presented in Tables 4.3, 4.4 and 4.5 representing units with high scoring pigs, medium scoring pigs and low scoring pigs respectively. The estimated percentage of time spent on each floor in each unit was noted under each floor category, e.g. in farm B in the high scoring category, the piglets in the farrowing house were allocated 40% of time to solid concrete (SC) and 60% of time to round metal rods (RMR).

The relationship between bursitis score, square root of bursitis score, log bursitis score and floor score respectively was examined and the best fit related to the square root of bursitis score. The correlation between square root of bursitis score and floor score is shown in Table 4.6.

Thus there is a highly significant correlation between bursitis score and floor category as analysed in this manner. ($p < 0.001$) The regression coefficient estimates are given in Table 4.7.

The severity of bursitis expressed as a score can then be predicted from the following equation:

$$\sqrt{\text{Bursitis score}} = 0.844 + 0.625 \text{ fls}$$

$$(\text{fls} = \text{floor score})$$

Using the floor score given in the example earlier the value of bursitis severity score could be predicted:

e.g.	Estimated floor score	=	0.35
	Therefore predicted mean bursitis score	=	$(0.844 + 0.625 + 0.35)^2$
		=	1.13

The relationship between the square root of bursitis score and floor score is shown graphically in Figure 4.2. As the floor score rises there is a steady increase in the bursitis score. The percentage time spent on each floor category in high, medium and low scoring farms, the number of farms in each group and the mean bursitis score per group are noted in Table 4.8

Table 4.3: Pigs with high mean scores and % of time spent on each floor category in each housing section.

Farm	Mean Bursitis Score	Housing Section	Floor Category (%) Hard	Intermediate	Soft	% Time in each Section
A	2.647	FH1	60SC/40FMR			8
		FH2	75SC/25FMR			9
		W1	50EM/50FMR			21
		W2(M)	100CS			15
		F(M)	100CS			17
		F(F)		75SC/25ST		30
B	2.339	FH	40SC/60RMR			17
		W1	60SC/40RMR			29
		W2	75SC/25CS			25
		F	75SC/25CS			27
C	2.164	FH		70WW/15S/15WW		12
		W1	100PS			8
		W2	100PS			17
		F1	100PS			63
		F2	80SC/20CS			
D	2.11	FH	60SC/40RMR			15
		W1	100PS			10
		W2	100EM			10
		F1	100EM			15
		F2	100CS			50
E	2.023	FH	60SC/40PS			12
		W1	100PS			21
		W2	100PS			34
		W3			100ST	17
		F	55SC/45CS			16
F	2.017	FH	25SC/75WW			12
		W1	100EM			21
		W2	100EM			21
		FIN	100CS			46
G	2.00	FH	60SC/35CS/5EM			12
		W1	100EM			21
		W2	100EM			21
		W3	55SC/45EM/70SC/30CS			29

Table 4.3 (Contd.)

Farm	Mean Bursitis Score	Housing Section	Floor Category (%) Hard	Intermediate	Soft	% Time in each Section
H	1.995	FH	70SC/25EM/CIS			12
		W1	100FIS			12
		W2	100EM			12
		W3	100RMR			17
		F	100SC			47
I	1.89	FH	60SC/40EM			17
		W1		50EM/50RM		12
		W2	55SC/45EM			21
		F	75SC/25CS			50
J	1.730	FH1		60SC/40ST		4
		FH2	50SC/50WW			15
		W1	60SC/40RMR			25
		W2	100FMR			8
		F	80SC/20CS			48

FH = Farrowing House W = Weaner House F = Finishing House

Table 4.4: Pigs with medium average scores and % of time spent on each floor category in each housing section.

Farm	Mean Bursitis Score	Housing Section	Floor Category (%) Hard	Intermediate	Soft	% Time in each section
A	1.449	FH	60SC/40EM			18
		W1		50EM/50RMR		20
		W2	60SC/40CS			20
		F1(M)	75SC/25CS			25
		F2(F)			100ST	17
B	1.443	FH1 or		30SC/70ST		9
		FH2		30SC/40ST/30FMR		9
		W1		60SC/40ST		9
		W2	100PS			13
		F1		70SC/30ST		20
		F2		60SC/30ST/10CS		40
C	1.38	FH	75SC/25RMR			13
		W1	100WW			9
		W2	100WW			13
		W3			100ST	13
		F1		80SC/20ST		52
D	1.36	FH		80SC/20ST		13
		W1	80SC/20FMR			13
		W2	80SC/20EM			9
		W3		70SC/30ST		13
		F	80SC/20CS			26
		or			100ST	26
E	1.327	FH	70SC/30FMR			6
		FH2	20SC/80ST			7
		W1	100PS or 100WW			13
		W2	80SC/20CS			13
		F			100ST	36
		or	80SC/20CS			25
F	1.267	F/H	70SC/30FMR			30
		W1 or			100ST	25
		W2	75SC/25CS			15
		F	70SC/30CS			30
G	1.250	FH	80SC/20ST			18
		W1	80SC/20S			36
		F	70SC/30S			46

Table 4.4 (Contd.)

Farm	Mean Bursitis Score	Housing Section	Hard	Floor Category (%) Intermediate	Soft	% Time in each Section
H	1.200	FH1	100WW			9
		FH2	60SC/40RMR			9
		W1	100FMR			5
		or				
		W2	50SC/50EM			4
		W3		70SC/30ST		9
		F1	100EM			9
		F2		70SC/30ST		19
		F3	70SC/30CS			18
I	1.087	FH	60SC/40FMR			18
		W1	60SC/40FMR			18
		W2	80SC/20EM			31
		F		70SC/30ST		33
J	1.043	FH1		50SC/50WF/S		10
		FH2		60SC/40SC/S		15
		W1		50SC/50SC/S		20
		W2		40SC/80SC/ST		25
		F		30SC/70SC/ST		30

FH = Farrowing House W = Weaner House F = Finishing House

Table 4.5: Pigs with low average scores and % of time spent on each floor category in each housing section.

Farm	Mean Bursitis Score	Housing Section	Floor Category (%) Hard	Intermediate	Soft	% Time in each Section
A	0.905	FH1		40SC/60ST		21
		W1		50SC/50ST		9
		W2		60SC/40ST		47
		F		60SC/40ST		23
B	0.855	FH1	55SC/45EM			16
		W1	60SC/40PS			12
		W2	55SC/45EM			25
		F			100 ST	47
C	0.782	FH	60SC/40PS			38
		W1		20SC/80ST		25
		W2			100ST	25
		F	85SC/15CS			12
D	0.588	FH	50SC/50WW			6
		or FH	50SC/50EM			6
		W1	100EM			17
		W2	25SC/75CS			8
		or	55SC/45CS			9
		F			100ST	54
E	0.377	FH1		60SC/40S		4
		and FH2	50SC/50WW			15
		W1	60SC/40RMR			25
		W2	100RMR			.8
		F			100ST	48
F	0.358	FH1	60SC/40FMR			18
		W1	50SC/50EM			28
		F1			100ST1	54
G	0.316	FH	55SC/45EM			12
		W1		50RM/50EM		17
		W2	100EM			10
		F1	60SC/40CS			7
		F2			100ST	54

Table 4.5 (Contd)

Farm	Mean Bursitis Score	Housing Section	Hard	Floor Category (%) Intermediate	Soft	% Time in each Section
H	0.190	FH		10SC/WF/90ST		4
		FH		10SC/90ST		17
		W2			100ST	30
		F1			100ST	45
		F2		10SC/90ST		4
I	0.087	FH		10SC/WF/90ST		8
		W1		10SC/90ST		34
		F			100ST	58
J	0.062	FH		10SC//WF/90ST		20
		W1			100ST	20
		F			\100ST	60

FH = Farrowing House W = Weaner House F = Finishing House

Table 4.6: Correlation Matrix square root of Bursitis score v. Floor score

	Correlation Matrix			
S score	1	1.000		
Floors	2	0.905	1.000	
Floors 2	3	0.472	0.641	1.000
		1	2	3

Table 4.7: Estimates of Regression Coefficients

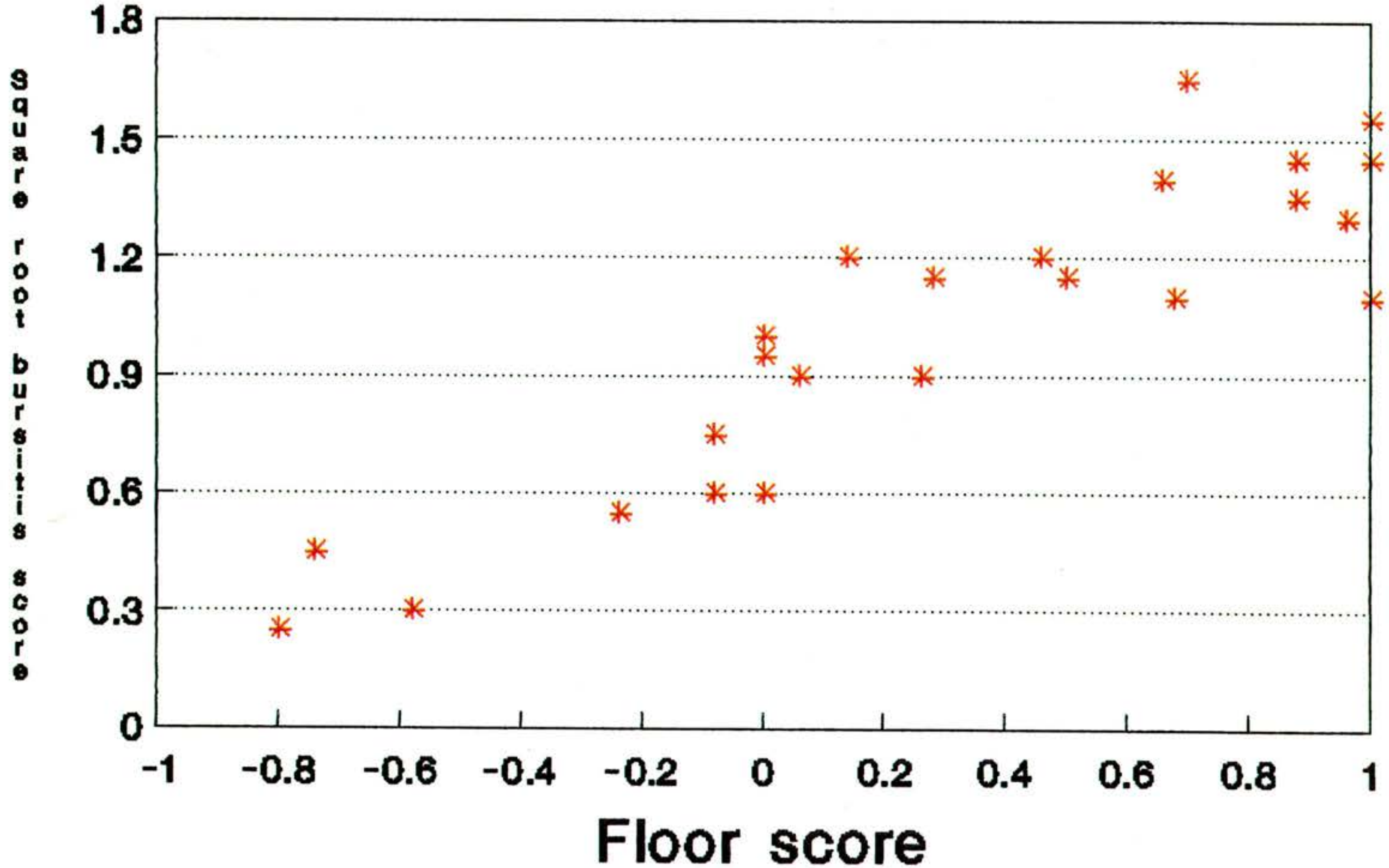
	Estimate	S.C.	t
Constant	0.8440	0.0366	23.03
Floors	0.6254	0.0566	11.06

Table 4.8: The percentage time spent on each floor category in high, medium and low scoring farms, the number of farms in each group and the mean bursitis score per group.

Scoring category	Average score	No. of farms	% Time spent on each floor category		
			Hard	Intermediate	Soft
High	2.092	10	96.7	3.3	0
Medium	1.281	10	35.7	54.2	10.1
Low	0.452	10	25.1	25.8	49.1

The average time spent on each floor category was calculated for each housing group with high, medium and low average scores and is tabulated in Table 4.8.

Fig 4.2 Square root of bursitis score against floor score



Discussion

High Scoring Farms

The data in Table 4.3 show, that of the 10 farms with high scoring pigs, the pigs in six of those farms were kept on hard floors all the time. In the other four farms, the pigs were kept on an intermediate floor for only 12%, 12% and 4% of the time in Farms C, G, and H respectively while in the fourth, pigs were kept on a soft floor for 17% of the time.(See Figure 4.3) Overall, pigs in the high scoring category spent 95.4% of their time on hard floors, 2.9% of their time on intermediate floors or 1.7% of their time on soft floors.

Thus the most important determinant would seem to be the presence of a hard floor, in particular cement, either as a solid floor or particularly in the form of concrete slats. The pigs with the highest score (2.647) came from unit (A) in which all the male pigs spent 62% of their time on concrete slats. The slats were 10.16 cm in width with a 2.50 cm gap and were well made with a smooth, rounded edge. It could be argued that slats with a sharp edge would lead to a more acute cutting type of injury rather than the more chronic diffuse lesion as is the case with adventitious bursitis. A glance at Figure 4.3 would suggest that units C and E are higher up the severity table than one might expect because the pigs spent some part of their time on either intermediate or soft floors. The explanation in the case of Unit C is probably related to the fact that the intermediate floor was in the farrowing house and the sawdust was confined to 20% of the floor area. In addition, the piglets were both young and light at this stage and were only confined on this floor for 12% of their lifetime. The pigs in this unit would have had ample opportunity to develop bursitis, as they spent the rest of their life on hard floors. Indeed they spent the final 63% of their time on solid concrete or concrete slats. In Unit E, the pigs spent 17% of their time on a soft floor (deep straw) in rearing stage 3, but then were housed in a combination of concrete and concrete slats for the remaining 16% of their lifetime. Any resolution of the bursae on the straw would have been negated, to some extent, by the tendency for concrete and concrete slats to cause severe bursitis.

Medium Scoring Farms

The data for pigs with medium range scores (Table 4.4) are also presented in histogram form (Figure 4.4). In the case of these units there may be considerable overlap in the time allocated to each type of floor, because in many instances the amount of bedding varied from batch to batch and the time spent by each batch in each housing section was not always uniform. In several instances a best **'guesstimate'** had to be made. Unit H exemplified a typical unit in the medium scoring category. This unit was originally built for 140 sows, but during the survey period the herd was reduced to 110 sows. Sometimes sows were farrowed in pens with floors made entirely of woven wire mesh, but more often they farrowed in pens with floors of part solid concrete, part round metal bars. (18% of the time). Then the first stage weaners were either housed in pens with flat metal bar floors or pens which had hard floors of 50% solid concrete and 50% expanded metal (9% of their time). The second stage weaners were then moved to pens with solid concrete floors but the lying area (70% of the pen) was covered with a thin layer of straw (9% of the time). The rearing pigs were then moved to a pen with an expanded metal floor (9% of their time). Finishing pigs could be housed in:

(a) a pen with a solid concrete floor in which the lying area (80% of the area) had a light covering of straw.

or

(b) a pen with a floor made of part solid concrete/part concrete slats (ratio 70-30),

or

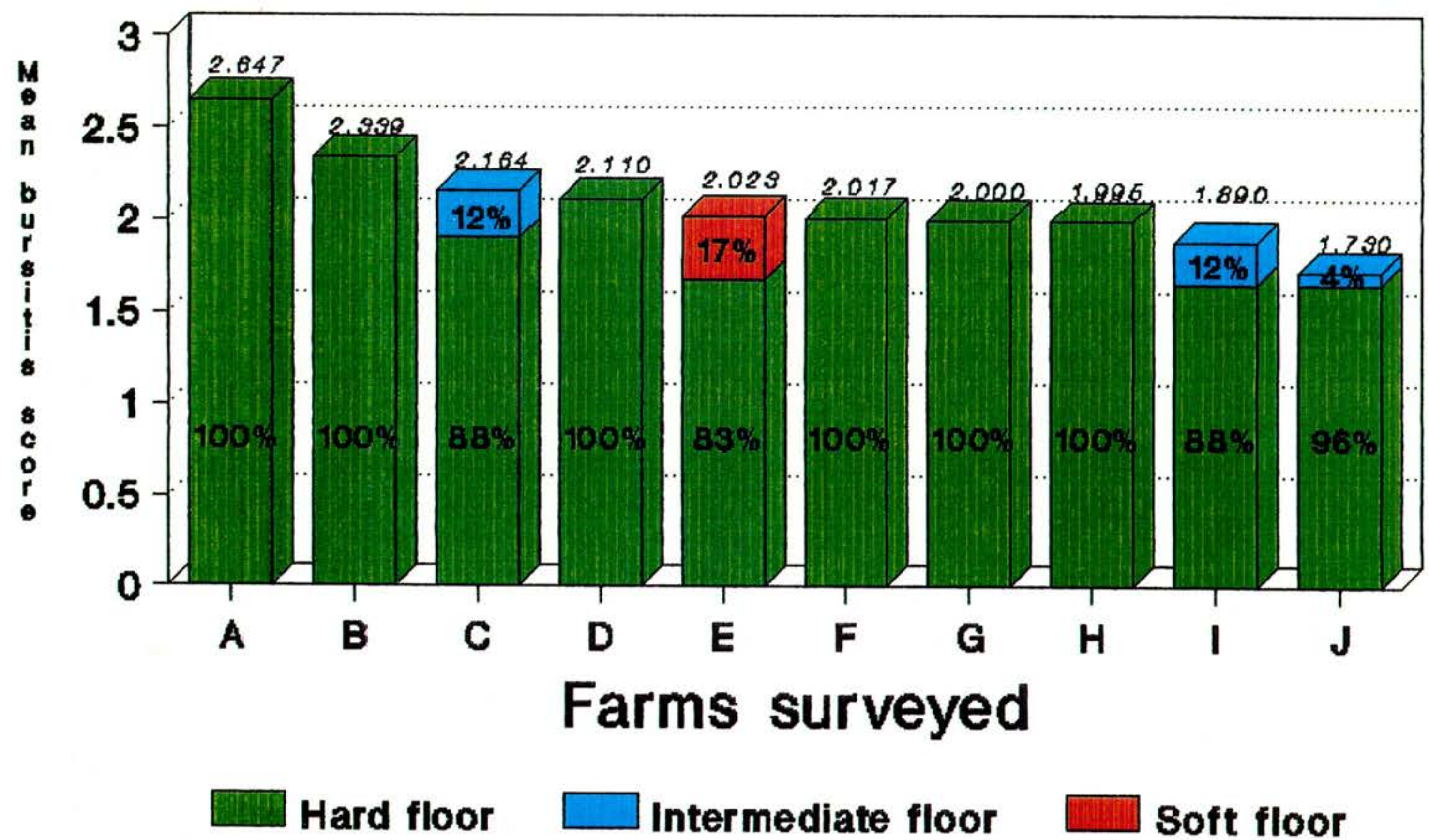
(c) a deep strawed court.

in each case for approximately 55% of their time.

According to the farmer, as there was excess accommodation, the number of pigs going through each housing system could have varied considerably.

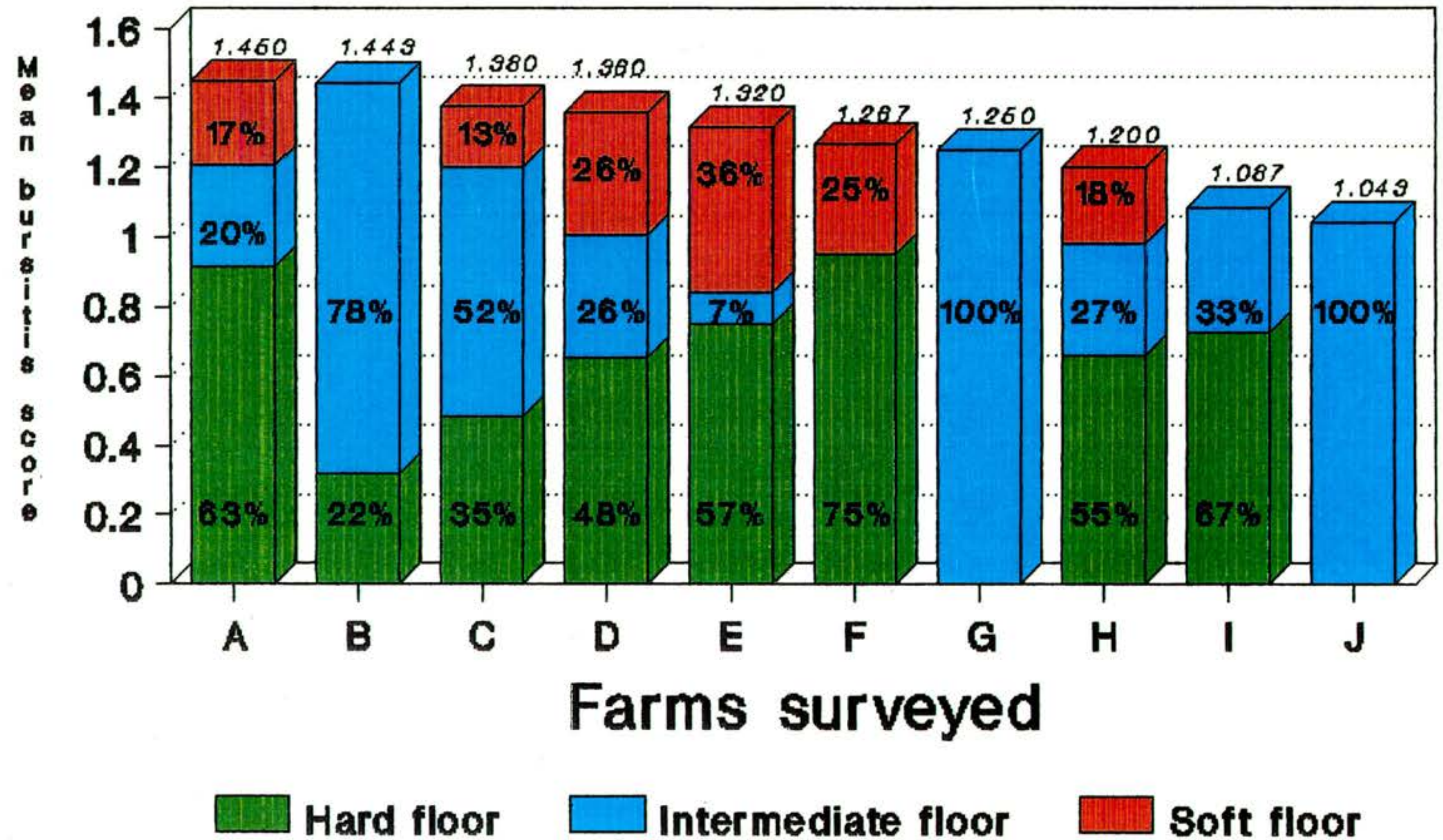
In Figure 4.4, the complexity of flooring in use is more obvious, and it can be clearly seen that the time spent on intermediate and soft floors was higher than in the high scoring groups. The palliative effect of bedding at the end of the housing period can be seen in a number of cases, in particular Unit F in which the pigs spent 75% of their time on hard floors. In fact, the total time spent on hard, intermediate and soft floors, in the medium scoring category, was 42.2%, 44.3% and 13.5% respectively.

Fig 4.3 The mean bursitis score and % time spent on the three floor categories



High scoring farms [birth to slaughter]

Fig 4.4 The mean bursitis score and % time spent on the three floor categories



Medium scoring farms [birth - slaughter]

Low Scoring Farms

The data in Table 4.5 are shown in Figure 4.5. This clearly shows the greater amount of time spent on soft floors as the severity of bursitis decreases. The highest scoring farm (A) in the group had no pigs on either hard or soft floors. In this case, all the floors were made of solid concrete with a covering of straw bedding. In the second highest scoring farm (B), the pigs were housed on a hard floor for 53% of the time but then spent the remainder of their time on a soft floor i.e. deep straw. This again demonstrates the **healing** effect of bedding on bursitis, and this is discussed more fully in Chapter 5. At the bottom end of the scale, as the severity of bursitis decreases, it can be seen that the pigs spend more time on intermediate or soft floors - especially the latter. Again, bedding seemed to play an important role in reducing the severity of bursitis. The total time spent on hard, intermediate and soft floors in this group was 27.2%, 23.3% and 49.5% respectively. As the score decreases from high to low, the time spent on soft floors increases significantly. Farm F was a finishing unit which bought in weaners from another unit, the owner of which would not allow a visit. The figures for time spent on each floor category and stocking density, were computed from data given by the owner of the breeding unit.

Berner et al (1990) noted that the number and size of adventitious bursae in sows kept in stalls with cast iron slats was greater than in sows kept on solid floors. Gerhard (1976) also observed that pigs kept on slatted floors had a higher prevalence and severity of bursitis. He attributed this to the fact that there was a smaller surface area for the extremities to rest on when sitting or lying on slats, compared with solid floors. Backstrom & Henricson (1966) in a farm study, noted that herds with a low prevalence of bursitis had a significantly greater supply of straw bedding. Probst et al (1990) in experimental studies on finishing pigs, noted that the pigs kept on bedded floors had significantly less bursitis compared with pigs on hard floors.

Behrens and Trautwein (1964) were initially of the opinion that the presence or absence of bedding had no effect, but after completing some detailed studies they concluded that a hard floor was important in the development of the lesion. Penny et al (1963) considered that bursitis was mainly due to trauma and lack of bedding. Orsi (1967) noted no difference in the prevalence and severity of bursitis in pigs kept on floors with or without bedding. However, he concluded in his discussion that frequent, repeated trauma was a required factor in the development of the disorder.

Pearce (1992) compared the activity of pigs in deep strawed pens, Straw-Flow pens and pens with concrete slatted floors and the amount of time spent active was 55%, 54% and 34% respectively. Thus the amount of time spent lying or resting on the concrete slats was 20% greater and this might also explain why concrete slats are associated with a high prevalence and severity of bursitis.

Lasson and Boxberger (1976), using modelling techniques, studied permissible stress levels on the carpal joint of a cow. They reasoned that the best floor was one which allowed maximum surface area of the limb to contact the floor as this would minimise pressure over a specific area. Nilsson (1988) noted that cubicles for cattle, with deep sawdust or sand, were very suitable for cows and prevented injury to the knees and hocks because the bed adapted (moulded) itself to the shape of the animal. This resulted in a better pressure distribution between the body and the bed. The degree of softness of the floor becomes more important as the weight of the animal increases because the contact pressure on the lying area becomes relatively greater (Nilsson 1988). Preference tests relating to the softness of floors were carried out with cows, and it was found that they preferred the floor (unspecified) covered with 15 cm of sawdust, and this was the softest floor on offer. It could be argued that the cows felt most comfortable (or felt less discomfort or painful stimuli) on this floor. It has been shown that injuries to the carpus and hock of the cow increase in prevalence and severity as the hardness of the floor increases (Wander, 1970), so it seems likely that the pig will respond in a similar fashion.

Conclusion

As the category of floor changes from soft to hard the prevalence and severity of bursitis increases; variation within groups can often be explained by management changes and the time spent on various floor categories on the farm.

This is more clearly seen in Figure 4.6. It may be noted that the high scoring farms have no pigs on soft floors while low scoring farms have pigs on hard floors for approximately 25% of their time. It is also of importance to note, that in the majority of cases these hard floors were used at the beginning of the pig's life rather than at the end, again suggesting that straw or soft bedding in the later stages can do much to reduce the severity of bursitis.

Influence of Stocking Density

Introduction

Veterinarians and other advisers often criticise farmers for keeping pigs too densely stocked or overstocked. There is no doubt that stocking density may be a factor which can affect the prevalence and severity of some diseases and disorders. Pneumonia in finishing pigs and flank biting in rearing pigs are two good examples (Svendsen and Svendsen, 1987 and Smith and Penny, 1986). Stocking density, as measured in kg/m^2, may also play a role in bursitis.

Objective

To determine the effect of stocking density on the severity of bursitis.

Materials and Methods

When each farm was visited the total weight of pigs was calculated on entry to a pen; when leaving a pen the pen dimensions were measured in each case, and an overall mean stocking density in kg/m^2 per farm was computed.

Statistical Analysis

The data were analysed in the manner already outlined in regard to floors, but in this case stocking density was added as co-variate.

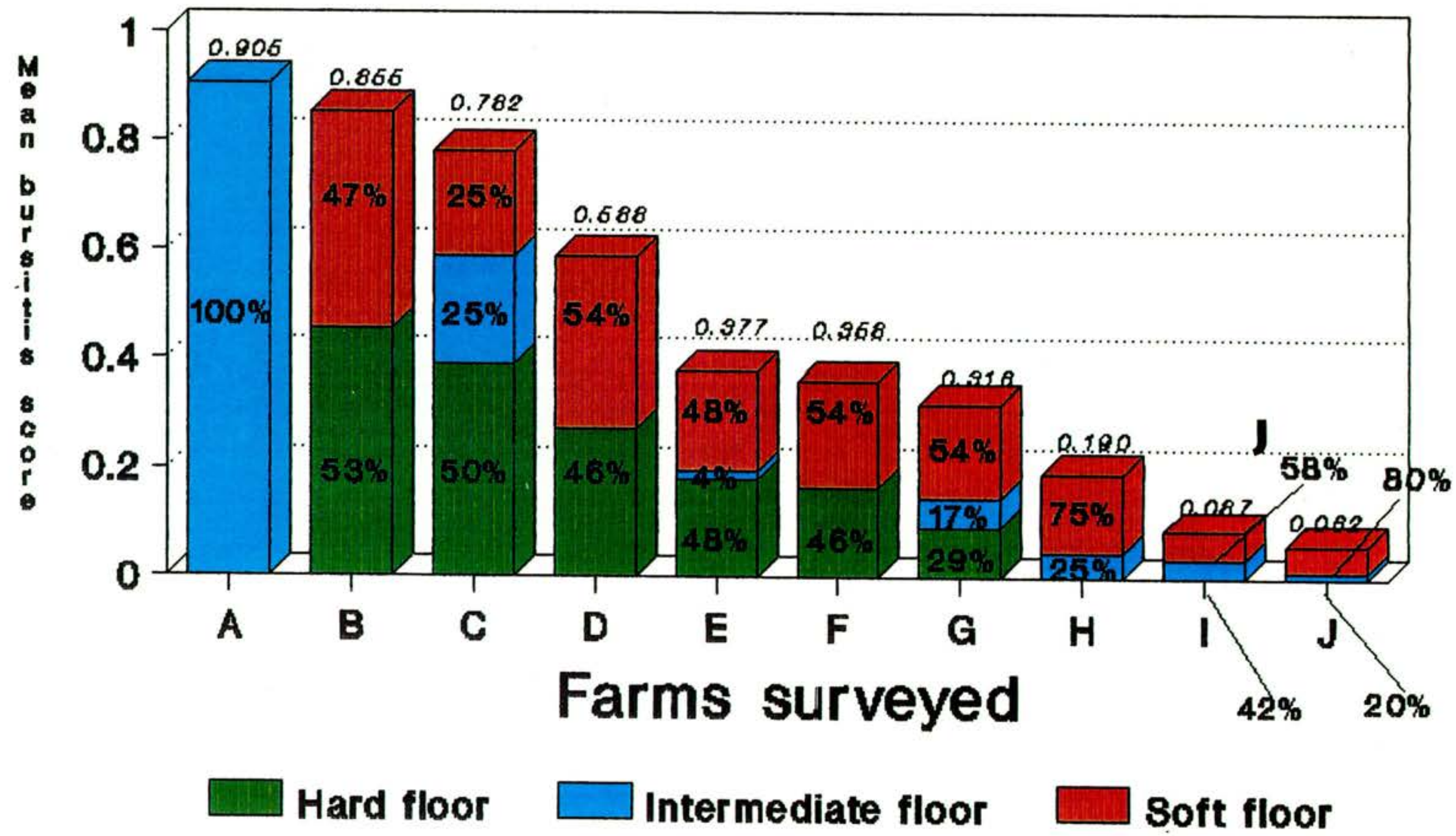
Results

The stocking density figures for each farm in each group are presented in Tables 4.9, 4.10, and 4.11 and the mean bursitis score for the pigs from each farm has also been included for purposes of comparison (see Appendix 4.5). The overall mean stocking density figures for each group (high, medium and low scoring) of farms are presented in Table 4.12 and the same data are shown in Figure 4.7.

Table 4.9: The mean stocking density (in kg/m^2) for each farm in the high scoring group and the mean bursitis score in each.

Farm	Mean Stocking Density (kg/m^2)	Mean Bursitis Score
A	130.0	2.647
B	60.9	2.339
C	72.2	2.164
D	90.7	2.11
E	111.4	2.023
F	104.1	2.017
G	130.5	2.000
H	96.7	1.995
I	66.1	1.891
J	86.4	1.730

Fig 4·5 The mean bursitis score and % time spent on the three floor categories



Low scoring farms [birth - slaughter]

Fig 4·6 The mean time spent on each floor type for high, medium & low scoring farms

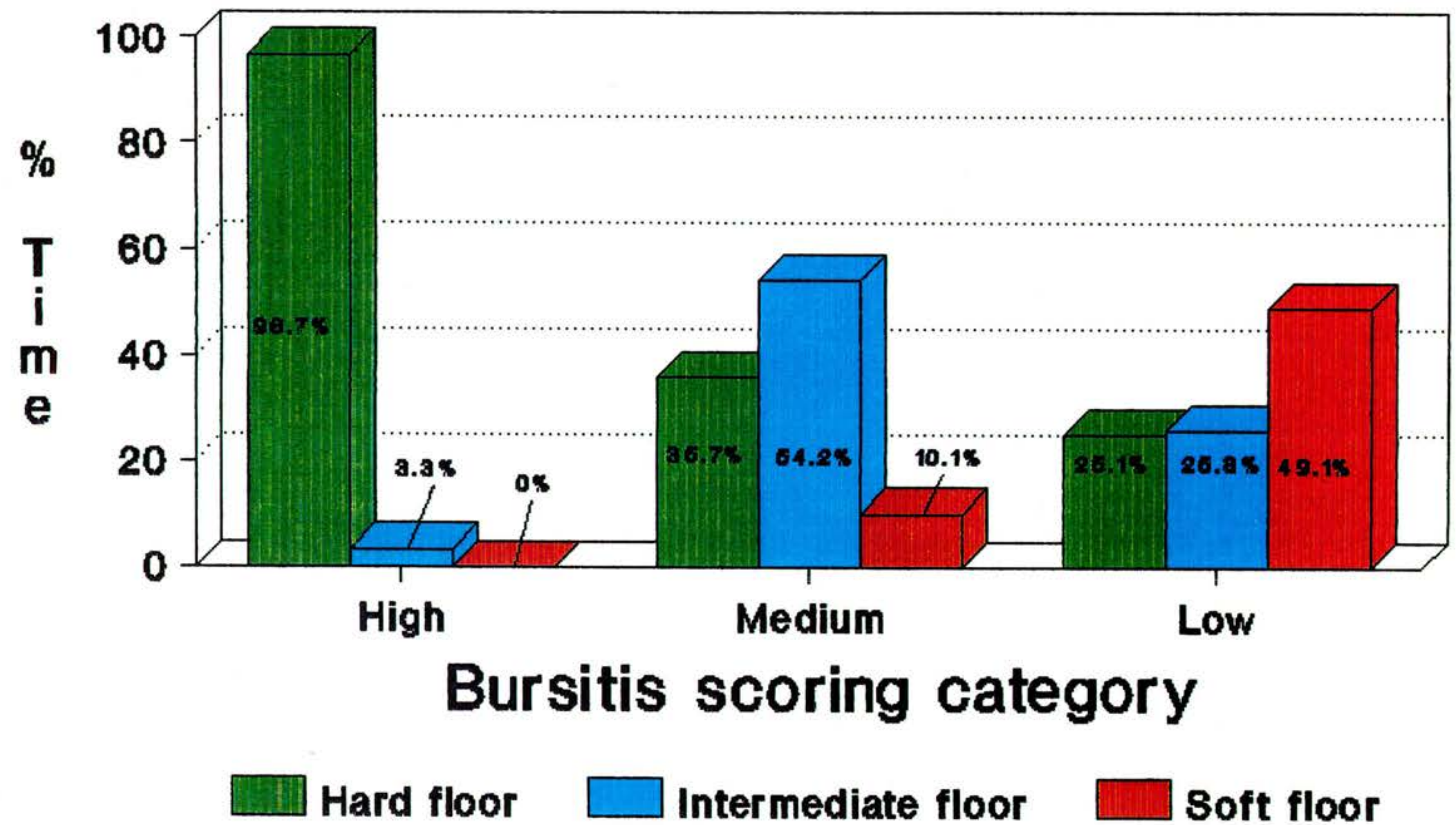


Table 4.10: The mean stocking density (in kg/m^2) for each farm in the medium scoring group and the mean bursitis score.

Farm	Mean Stocking Density (kg/m^2)	Mean Bursitis Score
A	90.3	1.449
B	90.6	1.443
C	108.0	1.380
D	72.2	1.360
E	66.7	1.327
F	70.6	1.267
G	73.8	1.250
H	75.6	1.20
I	59.0	1.087
J	63.8	1.043

Table 4.11: The mean stocking density (in kg/m^2) for each farm in the low scoring group and the mean bursitis score.

Farm	Mean Stocking Density (kg/m^2)	Mean Bursitis Score
A	61.0	0.905
B	101.6	0.855
C	65.3	0.782
D	54.8	0.588
E	58.6	0.377
F	55.35	0.358
G	74.4	0.316
H	33.6	0.190
I	55.0	0.087
J	71.9	0.06

Table 4.12: The mean stocking density figures for each scoring category on all the farms and the mean bursitis score in each category.

Scoring Category	Mean Stocking Density (kg/m^2)	Mean Bursitis Score	No. Farms
High	94.9	2.092	10
Medium	77.1	1.281	10
Low	64.0	0.462	9

The correlation between stocking density and bursitis was examined in the manner described and the correlation is shown in Table 4.13.

Table 4.13: Correlation matrix

S. score	1	1.000			
Fls	2	0.905	1.000		
Fls 2	3	0.472	0.641	1.000	
Sd	4	0.616	0.504	0.273	1.000
		1	2	3	4

S score	=	Bursitis score
Fls	=	Floor score
Fls 2	=	Floor score + floor score
Sd	=	Stocking density

There was a good correlation between the degree of bursitis and stocking density and a significant effect ($p < 0.05$) of stocking density (over and above floor effect) on bursitis (see Appendix 4.5). The regression coefficient estimates are shown in Table 4.14.

Fig4·7 The mean stocking density & bursitis score for each scoring category in all farms

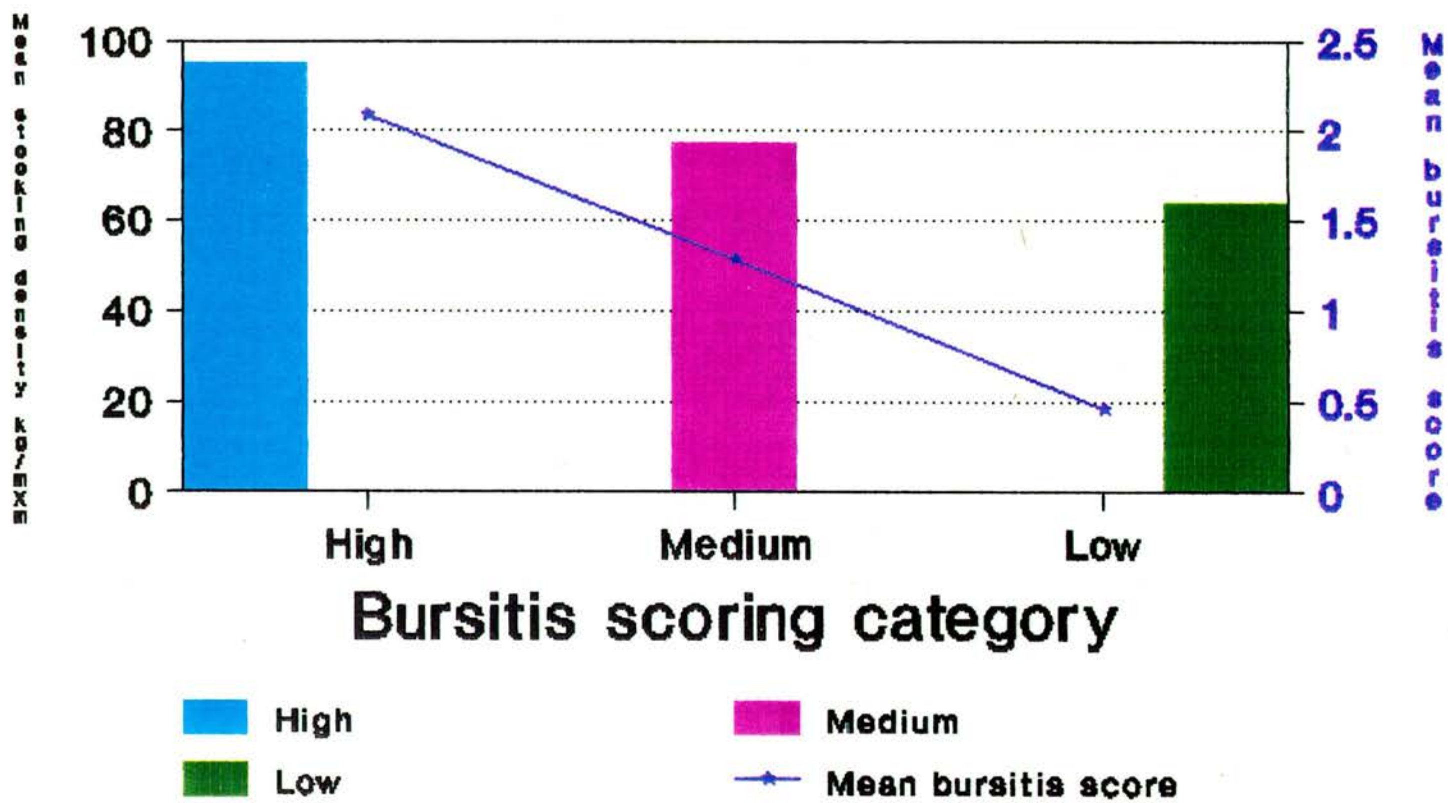


Table 4.14: Estimates of Regression Coefficients

	Estimate	SC	t
Constant	0.597	0.106	5.61
Fls	0.5510	0.0601	9.16
sd	0.00349	0.00142	2.45

The bursitis score can be predicted from the following equation:

$\sqrt{\text{Bursitis score}}$	=	0.598 + 0.551 + fls + 0.00349 x sd
fls	=	floor score
sd	=	stocking density (kg/m^2)

Discussion

As the bursitis score fell there was a corresponding decrease in average stocking density. This probably reflects the type of housing influencing each scoring category. In the high scoring category, pigs tended to be more densely stocked (mainly on slatted floors), whereas the low scoring category related to pigs kept in strawed pens, especially in the finishing accommodation. Indeed farmers are recommended to use higher stocking densities in slatted floor accommodation (Baxter, 1984). However, the fact that stocking density had a significant effect over and above the floor effect was interesting and reflected the views of farmers interviewed while collecting data for the housing survey. As stocking density increases there is less room to move around and attempts to do so might lead to more aggressive encounters. One could speculate that, faced with this situation, heavily stocked pigs might spend more time lying and this would explain the increased prevalence and severity of bursitis. Indeed, in their studies of pig behaviour in relation to space allocation, Ross and Curtis (1976) noted that pigs with the greater space allocation spent over a third more time walking and running, compared with the same group size more heavily stocked. Time spent lying/sitting was 18% greater at the higher stocking density.

Conclusion

Evidence collected from a farm housing survey clearly showed that, as the amount of time spent on bedded floors increased, the prevalence and severity of bursitis fell. In addition, there was a significant correlation between stocking density and bursitis over and above the floor effect.

It was apparent that bursitis could develop in pigs housed on a wide variety of floors. This study did not reveal the age at which bursitis might start to develop and it was decided to examine this aspect in suckling pigs and this is described in Chapter 5.

Chapter 5

FARM BURSITIS STUDIES

Introduction

Adventitious bursitis in the suckling pig was investigated in five studies. The general objectives of these were as follows:

1) To establish if adventitious bursae develop in suckling piglets.
2) To examine the relationship between bursitis, floor type and other lesions of the integument.
3) To examine bursal development in relation to time on farms producing pigs with either a high or low prevalence and severity of bursitis.
4) To study the severity of bursitis in pigs finished in different accommodation within the same farm.
5) To study the development of bursitis in pigs either reared on deep bedding or hard floors on the same farm.

Farm Busitis Study 1

Introduction

Adventitious bursitis in the suckling pig has not be described in the UK but was noted by Probst *et al* (1990). In fact, evidence from the literature would suggest that bursitis is mainly a disorder of the growing/finishing pig.

Objective

1) To establish if bursitis develops in the suckling pig.
2) To determine the prevalence of bursitis.
3) To determine the severity of bursitis.
4) To examine the development of bursitis in relation to time.
5) To study the role of infection.

Materials and Methods

Housing survey results indicated that bursitis was more prevalent and severe in pigs reared on hard floors. For this particular study, it was decided to carry out work in a farrowing pen with a hard floor. The pig unit on the College farm provided such a design where the pens were made of part solid concrete under the sow, with the rest of the floor being made of cast iron slats at the back of the pen and along one side. No bedding was used at all. Should bursae develop, 2 ml samples of fluid were to be taken in vacutainer tubes and examined both for the presence of organisms and cells. Fluids were to be cultured on 5% sheep blood agar and incubated in O_2 and 10% CO_2, and a mycoplasma medium (Friis, 1975) which was capable of growing *Mycoplasma hyosynoviae*.

In the first instance, the piglets were to be inspected on days 5, 12 and 19 and any bursae scored by the method already described. Any other lesions around the hocks were also to be noted. Three litters were chosen, two of which had farrowed on the same day and the third two days later.

Results

The number of pigs with bursae and the mean severity score for each litter at progressive examinations is shown in Table 5.1.

By day five, two pigs in one litter from sow 604 had developed bursae (one bilateral), one piglet from sow 603 had bilateral bursae and two piglets from sow 606 (on day three) also had bilateral bursae. All bursae were scored as 1. By day 12 no more bursae had developed in piglets of sow 604. However, two piglets in the litter of 603 had bursae and one of these also had capped hock (bilateral). In the litter of sow 606, six piglets had evidence of bursitis (four bilateral). By day 19, bursae had developed on the hocks of four piglets (one bilateral) in the litter of sow 604 and five piglets (three bilateral) in the litter of sow 603. Meanwhile in the litter of sow 606, bursae had developed on another piglet making seven in all. One pig with bursitis was rejected from the trial because of severe septic arthritis of the hock which was complicating the severity score. These findings have been summarised in Table 5.1 and Figure 5.1. The appearance of a bursa was always preceded by depilation of the same area over the hock, and indeed all those pigs which did not develop bursae had bilateral depilation of the plantar or latero-plantar area of the hock by 17 or 19 days of age. The depilated area of skin shows hyperkeratosis and elongated rete pegs (see Plate 3.10). Fluids were aspirated from six bursae and the results of cultural and cytological examinations have been included with the data in Chapter 3.

Table 5.1: The prevalence and severity of bursitis in suckling pigs and the number of days after birth on which they were examined.

Sow No.	Day No.	No. Pigs /Litter	No. Piglets with Bursae	Mean Bursitis Score	Prevalence %
604	5	7	2	0.214	28.5
	12	7	3	0.286	42.8
	19	7	4	0.429	57.1
603	5	10	1	0.100	10
	12	10	2	0.200	20
	19	9	5	0.444	55.5
606	3	10	2	0.20	20
	10	9	6	0.89	66.7
	17	8	6	1.19	75.0

These data have been merged and are also presented in Table 5.2.

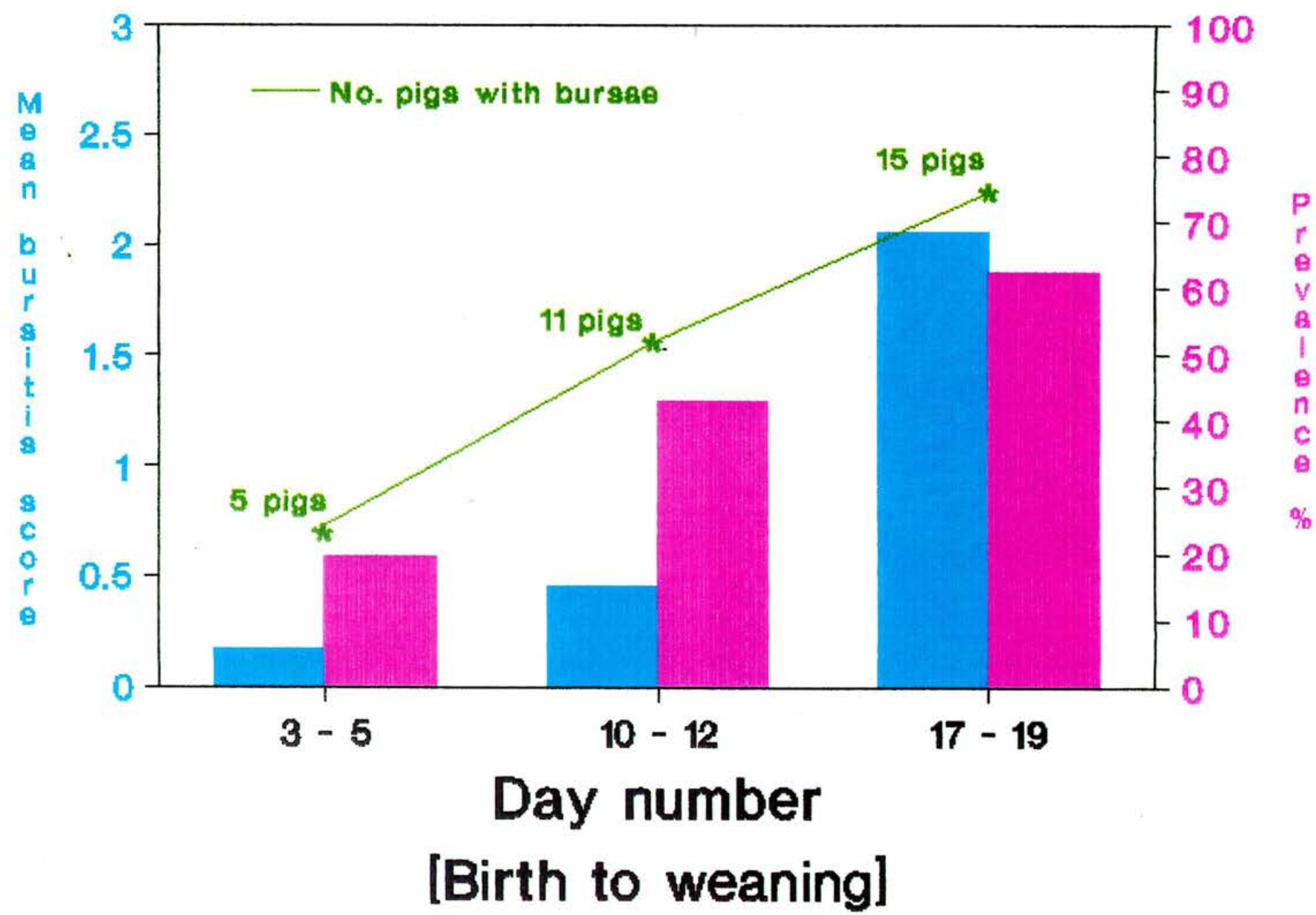
Table 5.2: The mean score and prevalence (%) of bursitis for all pigs examined on each occasion between birth and weaning.

Day No.	Total No. of Pigs	No. Pigs with Bursae	Mean Bursitis Score	Prevalence %
3-5	27	5	0.171	19.50
10-12	26	11	0.458	43.17
17-19	24	15	2.063	62.5

Discussion

It was interesting to note that two piglets in the same litter (606) had evidence of bursitis (score 1) by day 3 of age, while by day 5, the other two litters had one (603) and two (604) affected piglets respectively. With the passage of time more piglets became affected with bursitis while the severity score increased, so that by day 19, 62.5% of piglets had evidence of bursitis of the hock. Capped hock has only been described in finishing pigs or sows but in this case one piglet in litter 603 was showing evidence of this lesion by day 12 of life. If adventitious bursae on the plantar or lateroplantar aspect of the hock can develop by this age, there is no reason why capped hock should not develop as well. The dramatic rise in severity in the third week of age may be explained by the rapid increase in bodyweight. However, the reason why some piglets should develop bursae while others in the same litter do not, is not clear. Perhaps the suckling position may play a role but this was not studied in this particular trial. It was surprising to find bursitis in this age group, so it was decided to conduct a more in-depth study of suckling pigs and to examine other lesions of the integument.

Fig 5·1 The mean score & prevalence of bursitis for all pigs examined on each occasion



Farm Bursitis Study 2

Introduction

While handling piglets during Study 1 it was noted that many piglets had other lesions on the skin, especially the claws and knees. The opportunity to examine these lesions on three different farrowing room floors also arose.

Objectives

1. To study the development of bursitis on three different farrowing room floors between birth and weaning at 21 days of age.
2. To study the relationship between the prevalence and severity of bursitis and
   (a) Foot lesions
   (b) Knee necrosis
   (c) Daily liveweight gain
3. To study the role of infection.
4. To study the histopathology of recently formed bursae.

Material and Methods

An opportunity arose to carry out the above trial when it was learned that a farmer wished to lay new floors in his farrowing rooms and had asked The Scottish Agricultural College to monitor the health and welfare of the piglets. Three litters were followed through on each of three different floors as shown in Figures 5.2, 5.3 and 5.4. The sows were randomly allocated to each farrowing pen and newborn piglets were identified by placing a numbered ear tag in each ear. Data were collected regarding the following:

1. Birthweight
2. Claw lesions
3. Knee necrosis
4. Depilation around hocks
5. Bursitis of the hock and its severity
6. Bursal fluids
7. Weaning weight

Claw lesions were scored using the method of Smith and Mitchell (1977) on a specially prepared scoring sheet, (see Appendix 5.1) but in this case only severe bruising and erosions, or similar lesions, were counted.(see Plate 5.1).

The total number of claw lesions on both hind and fore feet were divided by the number of pigs in the litter, to give an average foot lesion score per pig. Knee necrosis was scored using the method of Smith and Mitchell (1977) and an average score for each pig was based on the maximum score reached in each knee (see Plate 5.2). Bursal fluids were aspirated by vacutainer from 15 piglets and the cultural results included in the data in Chapter 3. A biopsy was taken from three bursae after injecting 5% lignocaine into the cavity. The tissues were placed directly into 10% formal saline. The histopathological findings are detailed in Chapter 3. The piglets were examined every other day and data were collected from 29 piglets on Floor A, 25 piglets on Floor B and 24 piglets on Floor C. The correlation between bursitis, foot and knee scores was also examined:

(a) over all the data, and
(b) within floor types

Statistical Analysis

The data were analysed by analyses of variance, regression analysis and where appropriate, correlation coefficients were computed (see Appendices 5.2 and 5.3).

Results

The data collected are presented in Table 5.3 and summarised in Table 5.4 and Figure 5.5.

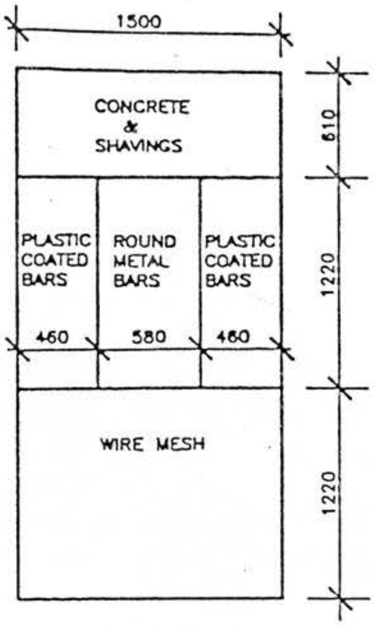


Fig 5.2 FARROWING PEN – FLOOR A

Fig 5.3 FARROWING PEN – FLOOR B

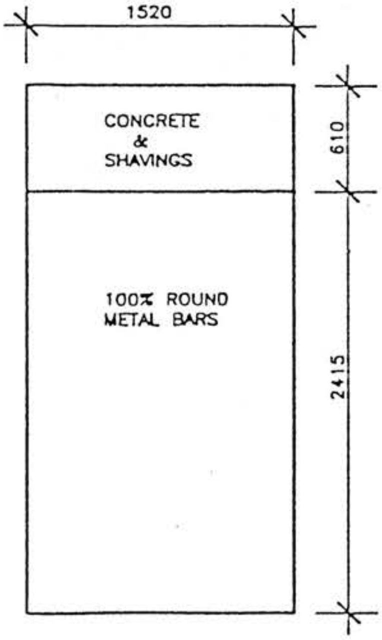


Fig 5.4 FARROWING PEN – FLOOR C

Plate 5.1: **Note the erosions in both medial claws of the hind legs**

Plate 5.2: **A three-day old piglet with knee necrosis score 3.**

Table 5.3: The number of pigs in each litter on each treatment and the bursitis score, knee score, foot score and weight data.

Floor	Pig ID	Mean Bursitis Score	Knee Score (0-5)	Birth Weight	Weaning Weight	Foot Score	DLWG g/day
A	41	0	2.5	1.5	3.8	5	135
	42	0.5	2	1.55	4.6	6	179
	43	0	1	1.55	4.8	0	191
	44	0	1	1.5	5.2	1	217
	45	0	3.5	1.6	4.8	0	188
	46	1	1	1.7	4.6	2	170
	48	0	1.5	1.65	4.4	2	161
	49	0.5	0.5	1.4	5.2	0	223
	50	1.5	1	1.55		7	
	51	0	2.5	1.4	4.2	2	164
	52	0	2	1.35	4.8	3	202
	53	0	2	1.3	5.0	2	217
	54	3	3	1.4	4.4	0	176
	55	1.5	3	1.4	4.2	8	165
	56	0	1	1.3	3.4	0	123
	57	1.5	3	1.3	4.6	2	194
	58	1	4	1.5	5.0	5	205
	59	2	0	1.4	3.8	3	141
	60	0.5	2.5	1.3	4.2	4	170
	61	0	1	1.2	4.8	0	212
	62	1	1.5	1.5	5.3	1	223
	63	0.5	0	1.25	5.2	1	332
	64	1.5	1.5	1.35	4.9	2	208
	65	1.5	1	1.3	5.2	3	229
	66	2	1.5	1.2	4.6	2	200
	67	0.5	3	1.2	5.1	0	229
	68	2	2	1.1	4.9	6	223
	69	0	1	1.2	5.2	0	235
	70	1	0.5	1.2	5.3	5	241
B	71	0.5	1.5	1.55	5.2	1	214
	72	0.5	1.5	1.5	5.5	3	235
	74	0.5	2	1.7	5.5	0	223
	75	0	1	1.4	5.5	2	241
	76	0	4.5	1.45	5.5	6	238
	77	0	3.4	1.35	5.4	0	238
	78	1	1	1.6	5.6	0	235
	79	0	3.5	1.5	5.45	0	232
	31	1	3	1.8	5.4	7	211
	33	0	0.5	1.45	5.45	2	235
	35	1	2	1.4	5.4	10	235
	36	0.5	1	1.4	5.2	0	223

Table 5.3: (Contd.)

Floor	Pig ID	Mean Bursitis Score	Knee Score (0-5)	Birth Weight	Weaning Weight	Foot Score	DLWG g/day
	37	0	2.5	1.6	6.8	0	305
	38	0	1	1.3	4.4	3	182
	39	0	2.5	1.5	5.6	6	241
	40	0	2	1.35	5.0	4	214
	12	0.5	3	1.7	5.0	2	194
	13	0.5	1.5	1.9	8.0	2	358
	14	0	1	1.7	7.6	7	347
	15	0	3	1.5	5.4	2	229
	16	0	4	1.6	5.8	0	247
	17	1	4	1.6	7.2	12	329
	18	0	2.5	1.5	4.0	2	147
	19	0	1	1.7	4.4	0	158
	20	0	3	1.6	5.4	3	223
C	21	0	3.4	1.5	7.2	18	335
	22	0	5	1.5	6.6	1	300
	23	1	5	1.5	7.2	8	335
	24	0	4	1.5	5.4	3	229
	25	0	1	1.75	7.0	0	238
	26	0	3	1.55	5.6	4	270
	27	1.5	2.5	1.6	6.2	1	270
	28	0	2.5	1.65	6.8	1	302
	29	0	2	1.75	6.7	0	291
	30	0	4	1.45	7.0	14	326
	81	1	3	1.6	5.2	1	211
	82	2	1.5	1.8	6.8	2	294
	83	0.5	2	1.5	5.4	1	229
	86	2	3	2.0	6.4	4	258
	87	0	1.5	1.4	5.6	1	247
	88	2	1	1.4	5.0	2	211
	89	0.5	1.5	1.65	5.8	0	244
	90	1.5	1.5	1.70	5.8	2	241
	1	2	4.5	2.5	8	11	323
	3	3	3	2.1	8	3	347
	4	0	1	1.9	7.2	13	311
	5	1.5	4	2.0	6.6	8	270
	6	2.5	4	2.0	7.85	4	344
	7	2	1	2.0	7.2	7	305
	8	1	3	2.0	6.8	9	282
	9	0	2	2.0	7.8	0	341

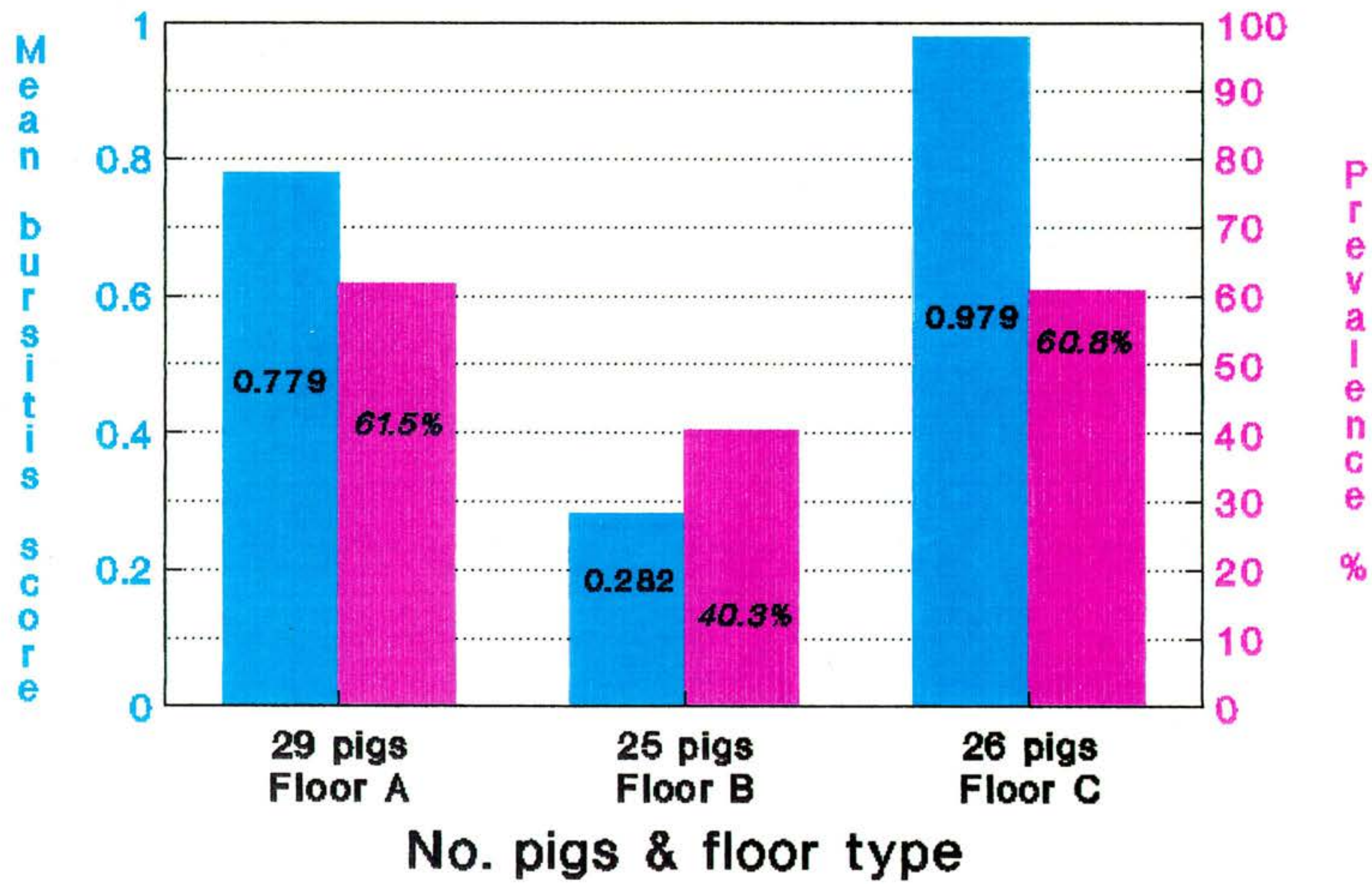
DLWG = daily liveweight gain

Table 5.4: Combined data from Table 5.3 showing the prevalence of bursitis, the prevalence of depilation only and the prevalence of knee necrosis.

	Litters & Floors		
	Floor A Litters 1-3	**Floor B Litters 4-6**	**Floor C Litters 7-9**
Number of pigs	29	25	26
Average Number foot lesions/pig	2.48	2.94	4.57
Prevalence (%) lesions	72	72	84.6
Average knee score	1.720	2.235	2.49
Prevalence (%) knees	93	100	100
Average bursitis score	0.779	0.282	0.979
Prevalence (%) bursitis	62	40	57.6
Prevalence of depilation only (%)	34.5	56	57.6
Average birth weight (kg)	1.39	1.55	1.76
Weaning weight (kg)	4.69	5.58	6.58
Liveweight gain (kg/d)	0.20	0.24	0.29

The prevalence and severity of bursitis was highest in the piglets on floor C where the floor was composed entirely of round metal bars. The best floor in relation to bursitis was floor B which was made entirely of plastic coated bars. Although analysis of variance revealed large differences in the severity of bursitis between the floor types, these were not significant because of the large differences in mean scores for litters on the same floor (see Appendix 5.2). Similar analysis indicated that there were no significant differences in foot scores or knee scores between treatments (see Appendix 5.2). Although the daily liveweight gain was best on floor C, on which the bursitis scores were also the highest, analysis of variance revealed that there was no significant effect of growth rate on bursitis score. The total number of pigs in each treatment was insufficient to examine the effect of daily liveweight gain on the prevalence of bursitis.

Fig 5.5 The no. of pigs on each floor, mean bursitis score & prevalence of bursitis



There was no evidence of a relationship between bursitis score, and either of the other scores, in both analyses, but there was a small but signficant correlation between knee and foot scores over all the data ($p < 0.01$) and within floor types ($p < 0.05$) (see Appendix 5.3). With regard to bursal development, the first lesion noted, was depilation of the plantar or latero-plantar aspect of the hock. Depilation over the central tarsal area was noted in one pig on Floor C, in which a bursa developed on the medial aspect of the left hind leg. Depilation was seen as early as day 3 (one piglet) and distinct fluctuating bursae by day 9 (two piglets) (see plate 5.3). One bursa in a pig in litter 8 Floor C, occurred without depilation appearing first (see Table 5.5). On average, the bursae appeared almost exactly a week after the appearance of depilation over the same area. Of the 43 piglets which developed bursitis, 12 were on the latero-plantar aspect, 30 were on the plantar aspect and one was on the medial aspect. The bursae remained soft and fluctuating until weaning in all cases, apart from two pigs in the same litter on Floor A. Both of these had developed bilateral lateroplantar bursae by day 13, but when examined on day 17 (day of weaning) the bursae on the right hocks of both pigs had become quite hard.

Discussion

Thus, although there were distinct trends in some lesions on different floors, the small scale of the trial and the large variability encountered within treatments did not enable significant differences to be detected. Nevertheless, the results resemble the findings of other workers in relation to injuries on slotted metal floors and the improvement brought about by the use of plastic, which softens the harshness of metal and rounds off sharp edges. (Smith and Mitchell, 1976, Svendsen et al, 1979). Although there was no effect of daily liveweight gain on bursitis score, it would be wrong to assume that this trait was unimportant, bearing in mind the number of pigs involved. As the pig becomes heavier, a proportionately greater stress is imposed on the small area of the leg bearing weight when the piglet is lying or sitting. The lack of a correlation between bursitis score and the other two lesions of the leg (knee and foot) which are related to each other, would support the hypothesis that the former has a different pathogenesis from the latter. Both knee and foot lesions are probably caused by a combination of friction, due to rubbing and the abrasiveness of the floor (Smith and Mitchell, 1976, Penny et al 1963), while bursitis develops as a result of pressure. However, friction probably plays a minor role in the development of bursae as these lesions are almost always preceded by depilation of the skin under which the bursa develops. It is unlikely that depilation would occur as a result of pressure alone (Munro, 1991). A difference in the prevalence of bursitis between treatments is understandable, but a large difference between litters on the same treatment, is not so easily explained. Why only 20% of the piglets in one litter on Floor C, but nearly 90% of another litter on the same floor should develop bursitis is puzzling, to say the least. In the first farm study, bursae developed as early as five days of age. However, the farrowing room floors were quite different (cast iron slats as opposed to round metal rods). It was noted in the housing survey that concrete slats in finishing pigs were always associated with severe bursitis. Taking the hardness and shape into account, a small cast iron slat may have the same effect on a baby piglet as a concrete slat has on a finishing pig. Berner et al (1990) noted that sows kept on cast-iron grates had a higher prevalence of bursitis of the hocks, compared with sows kept on solid concrete.

Backstrom and Henricson (1966) noted a boar effect on the incidence of bursitis on one farm, so it is possible hereditary factors played a significant role in this study. However, the sows in this case were served naturally, and with AI using mixed semen. In their studies on different floor treatments in farrowing pens, Svendsen et al (1979) noted injuries to the legs "*mostly consisted of hairless patches, abrasions or scabs. In time, the affected skin often became thickened and hyperkeratotic*". However, no mention of bursae was made by these workers.

Conclusion

Bursae begin to develop at an early age in suckling pigs and their presence is always preceded by depilation of the area of skin under which the bursae appear. The conditions which gives rise to the formation of bursae (pressure mainly) are different from those which cause feet and knee lesions (friction mainly). It is likely that plastic covered metal floors are kinder to pigs' feet and legs than untreated perforated metal floors.

Table 5.5: The time noted between birth and first evidence of depilation or formation of bursitis in each litter on each treatment.

Floor	Litter Number	First signs Depilation Day Number	First signs Bursitis Day Number
A	1	5	13
	2	5	11
	3	5	9
B	4	5	13
	5	5	11
	6	5	13
C	7	6	14
	8	3	9
	9	7	11
Average		**5.1**	**11.5**

Plate 5.3: **Note bilateral bursae on the lateroplantar aspect in this 9-day old piglet.**

Farm Bursitis Study 3

Introduction

During the collection of data at the abattoir it became clear that some farms consistently produced pigs with a high prevalence and severity of bursitis while a few farms consistently produced pigs with little or no bursitis. It was decided to study the development of bursitis from birth to slaughter on some of these farms.

Objectives

1. To follow the development of bursitis in each housing stage on four farms producing Landrace x Large White pigs with a high prevalence and severity of bursitis.

2. To follow the development of bursitis in each housing stage on one farm producing pigs with a low prevalence and severity of bursitis.

Materials and Methods

The above farms were identified from the league table created from the abattoir survey data. Piglets were individually identified at birth by placing a numbered ear tag in the right ear, and subsequently by ear tattooing. They were weighed at birth, weaning and at each subsequent housing stage. The prevalence and severity of bursitis was assessed as described in Chapter 2. In order to assist the examination of smaller pigs a trough-shaped wooden restraint device was constructed (Plate 5.4) and for larger pigs a specially made turning device was used. (Plate 5.5)

Statistical Analysis

The data were analysed by using a generalised linear model for analysing binomial type data, in which the proportion of pigs with bursitis was modelled by the effects of weekly change and farm (see Appendix 5.4).

Results

The time spent in each housing unit and the type of flooring used in each case is shown in Tables 5.6-5.10. The prevalence of bursitis and the mean bursitis score for each group at each housing stage is also noted. These data are also shown in Figures 5.6-5.10.

Plate 5.4: **Trough-shaped wooden device in which smaller pigs were restrained by placing them on their backs**

Plate 5.5: **Handling device for larger pigs. The pig walks in and then the device is rolled so that the pig becomes lodged on its back.**

Table 5.6: The time spent in each housing section, the type of floor and prevalence and average severity score for bursitis in each group in each housing section.

Farm A

	Housing Section				
	Farr. House	**Flat Deck**	**Stage 1**	**Stage 2**	**Finishing**
Floor type	**Conc.+ Flat + metal rods + sawdust**	**Flat Metal rods**	**Expanded metal**	**Round metal rods**	**Conc. slats**
Time	3 wks	2 wks	3 wks	4 wks	2-3 mths
No. pigs	41	41	41	41	41
Prevalence bursitis	4.9%	17.07%	39.02%	80.48%	95.1%
Severity bursitis	0.049	0.146	0.438	1.012	2.45
Av. weight(kg)	6.23	11.97	21.05	41.0	89.5

Table 5.7: The time spent in each housing section, the type of floor and prevalence and average severity score for bursitis in each group in each housing section

Farm B

	Housing Section			
	Farr./House	**Kennel**	**Stage 2**	**Finishing**
Floor type	**Conc. + straw wk 1 only**	**Conc. + metal strips**	**Metal strips**	**Conc. + conc. slats**
Time	4 weeks	7 weeks	3 weeks	2½-3 months
No. pigs	59	58	57	50
Prevalence bursitis	13.56%	62.07%	80.7%	90.0%
Severity bursitis	0.177	0.920	1.364	1.730
Average weight(kg)	7.39	30.86	45.33	89.6

Conc. = concrete Farr. = Farrowing

Fig 5.6 The prevalence and severity of bursitis at each successive housing stage

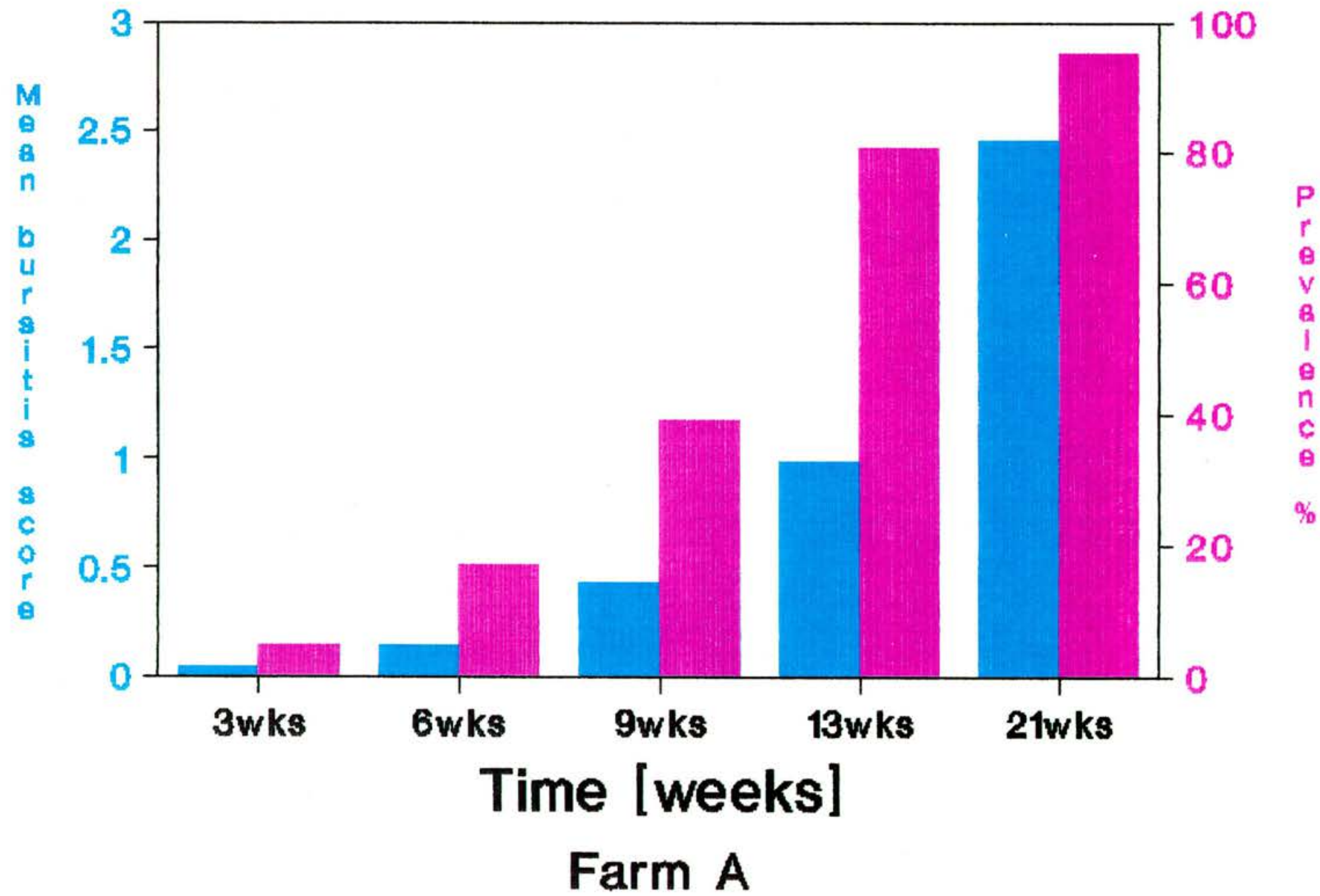


Table 5.8: The time spent in each housing section, the type of floor and prevalence and average severity score for bursitis in each group in each housing section.

Farm C

	Housing Section			
	Farr./House	**Flat Deck**	**Stage 2**	**Finishing**
Floor type	**Conc + cast iron slats**	**Expanded metal**	**Expanded metal**	**Concrete slats**
Time	3 weeks	4 weeks	4 weeks	2-2½ months
No. pigs	48	48	48	48
Prevalence bursitis	62.5%	72.9%	93.75%	97.92%
Severity bursitis	0.791	1.295	1.766	2.050
Average weight(kg)	6.26	22.03	43.07	88.9

Table 5.9: The time spent in each housing section, the type of floor and prevalence and average severity score for bursitis in each group in each housing section.

Farm D

	Housing Section			
	Farr./House	**Flat Deck**	**Stage 2**	**Finishing**
Floor type	**Conc.+woven wire**	**Expanded metal**	**Expanded metal**	**Conc. slats**
Time	3 weeks	5 weeks	5 weeks	3 months
No. pigs	34	34	34	34
Prevalence bursitis	61.8%	67.6%	100%	100%
Severity bursitis	0.690	1.037	1.860	2.139
Average weight(kg)	4.73	12.25	32.96	90.1

Conc. = concrete Farr. = Farrowing

Fig 5.7 The prevalence and severity of bursitis at each successive housing stage

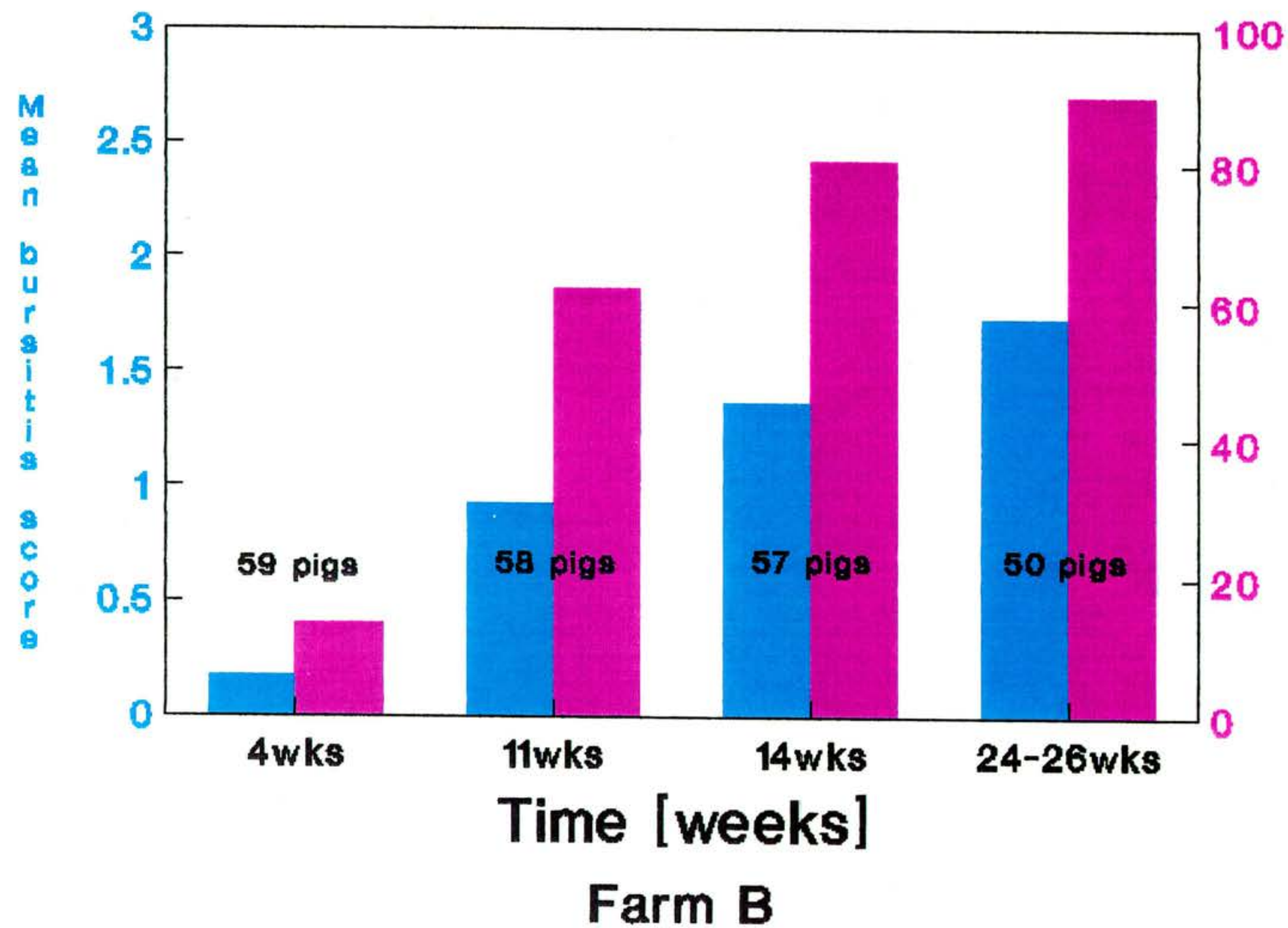
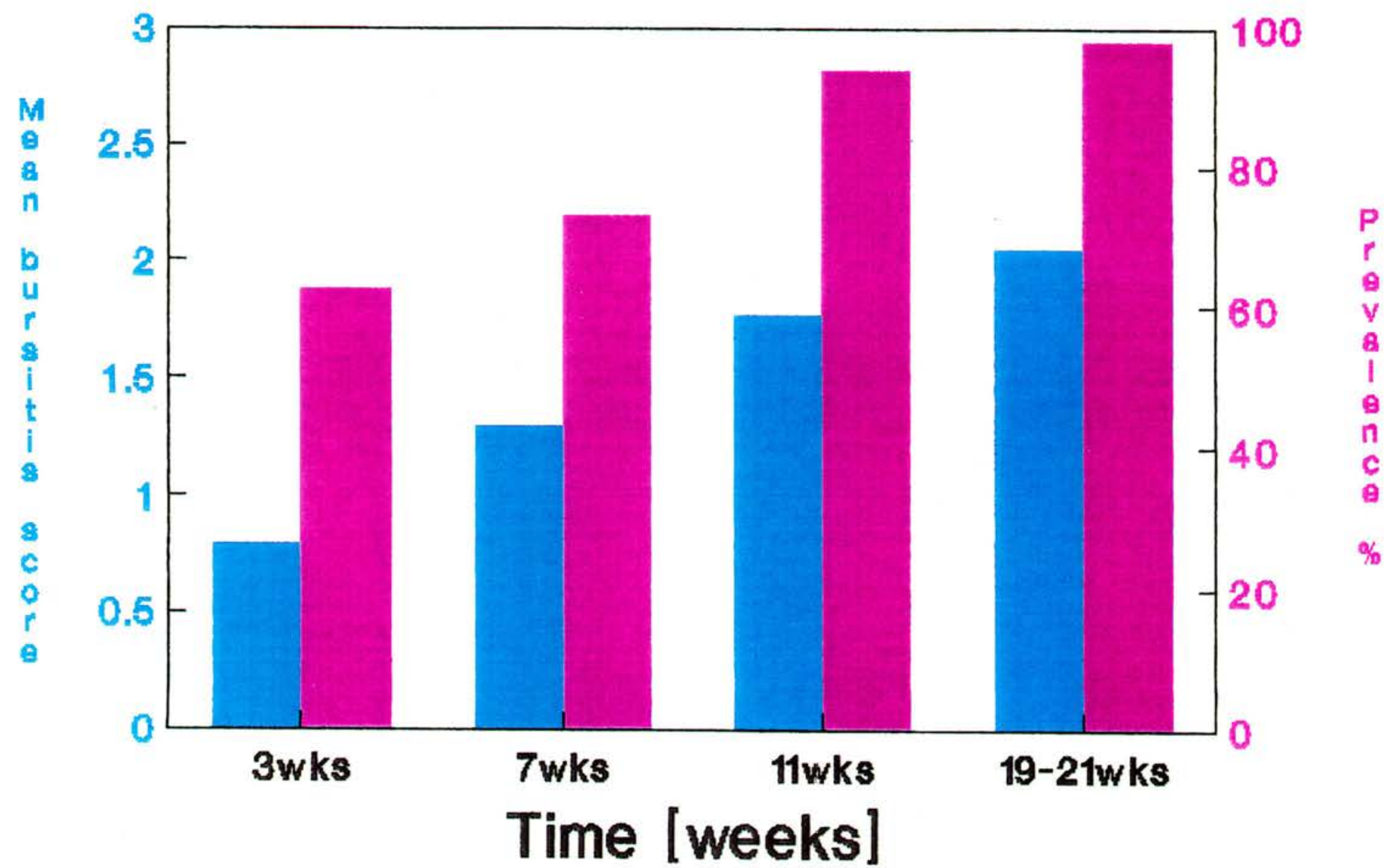


Fig 5.8 The prevalence and severity of bursitis at each successive housing stage



Farm C

Table 5.10: The time spent in each housing section, the type of floor and prevalence and average severity score for bursitis in each group in each housing section.

Farm E

	Housing Section	
	Farrowing	**Court**
Floor type	**Deep straw**	**Deep litter straw**
Time	8-10 weeks	3-4 months
No. pigs	55	42
Prevalence	0%	9.52%
Severity	0	0.083
Average weight(kg)	20	88.1

Analysis of the data in the manner outlined showed that the four farms in the high scoring category fell into two distinct groups; namely Farms A and B and Farms C and D, with the essential difference between them being the prevalence of bursitis in the first 3-4 weeks of life. An accumulated analysis of deviance showed a large weekly effect and a large farm effect on the prevalence of bursitis (see Appendix 5.4). A number of pigs failed to reach slaughter weight because of death, or the fact that they simply went **missing** on the farm.

Discussion

The ameliorative effect of bedding in the farrowing pens is immediately seen. At weaning the mean prevalence of bursitis in Farms A and B was 4.9% and 13.56% respectively, while the mean prevalence of bursitis in Farms C and D was 62.5% and 61.8% respectively. The pigs in Farm B were in the farrowing room for one week longer than the other farms. In the case of Farms A and B, the bedding was never deep at any time and light bedding is easily swept to the side by both sow and piglets. The presence of slatted floors in the farrowing houses in Farms C and D, probably played a significant role in the higher level of bursitis noted in these two farms. However, after weaning the prevalence of bursitis in Farms A and B rapidly increased (see Figure 5.11). It is clear that when pigs were kept on hard floors all their lives there was a steady and rapid increase in the prevalence and severity of bursitis. In fact, given the wrong environmental conditions, all pigs of the Landrace x Large White type will develop bursitis to some degree, as was the case in Farm C. The piglets in Farms C and D had significantly higher levels of bursitis at weaning. Cast iron slats were used in suckling area in Farm C, while woven wire mesh pens were used in Farm D. Both types of floor would have a relatively narrow edge for the piglets to lie on compared to the round metal rods (much thicker than woven wire) and the solid concrete of Farms A and B respectively. One farm (B), had a lower prevalence and severity of bursitis at slaughter than the other three farms. The main difference was the floor in the final finishing section. In this section in Farms A, C and D, the floors were made of fully slatted concrete, but in Farm B the concrete slats only extended to one-eighth of the pen floor area, i.e. the dunging area on which the pigs seldom lay. The role played by concrete slats is discussed in more detail in Chapter 4.

There was a highly significant difference in the prevalence and severity of bursitis between the pigs of Farm E and those of Farms A-D. The most obvious difference between Farm E and the others was the use of straw bedding throughout (see Plate 5.6). Although the pigs in the court (barn) were bedded on deep straw in Farm E, the farmer stated that occasionally the pigs could root down to the concrete and expose a bare area. Nevertheless, only four pigs showed evidence of bursitis and the average severity score was very low (0.083). These pigs were pure Welsh Landrace and in certain circumstances, this type of animal will be more likely to develop bursitis (Backstrom and Henricson, 1966, Orsi, 1967).

Conclusion

The provision of a small amount of bedding in the farrowing house will reduce the prevalence and severity of bursitis markedly. Nevertheless, pigs reared in such accommodation, when placed on hard floors, will rapidly develop bursitis to the same extent as those reared on hard floors from birth. When pigs are reared on floors made wholly of concrete slats they may all develop bursitis. However, when pigs are reared on bedding from birth to slaughter, the prevalence and severity of bursitis will be extremely low.

Fig 5.9 The prevalence and severity of bursitis at each successive housing stage

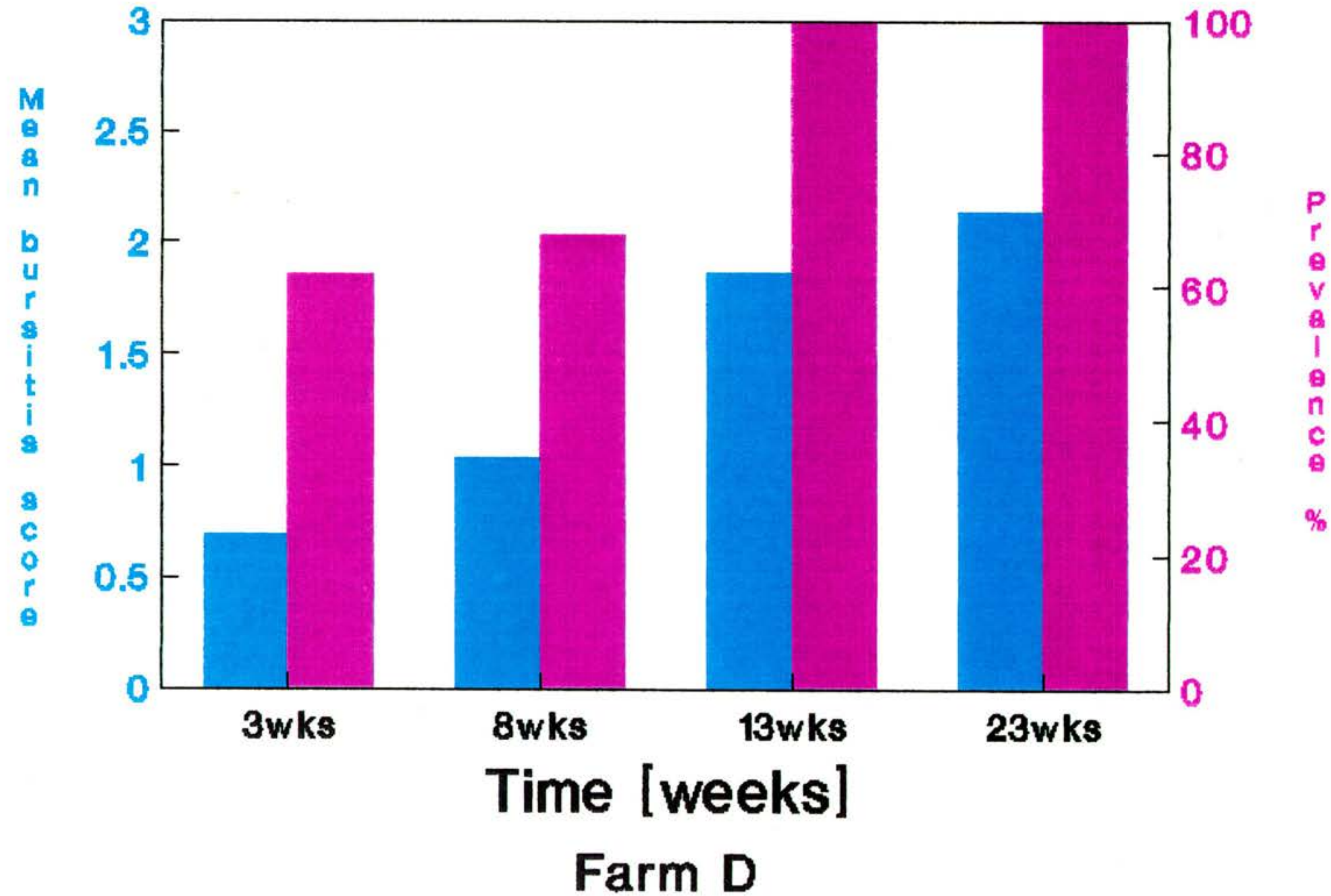
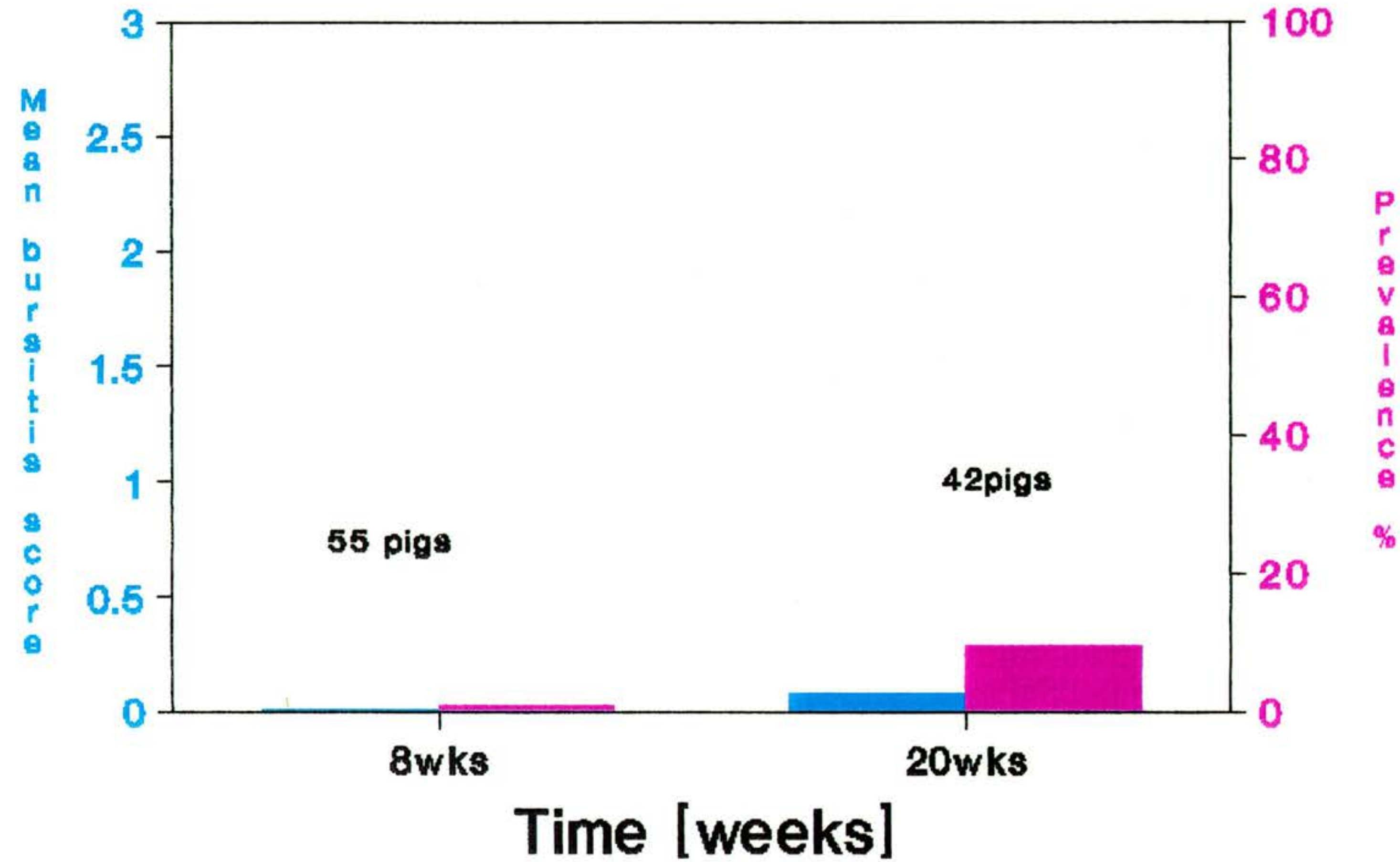


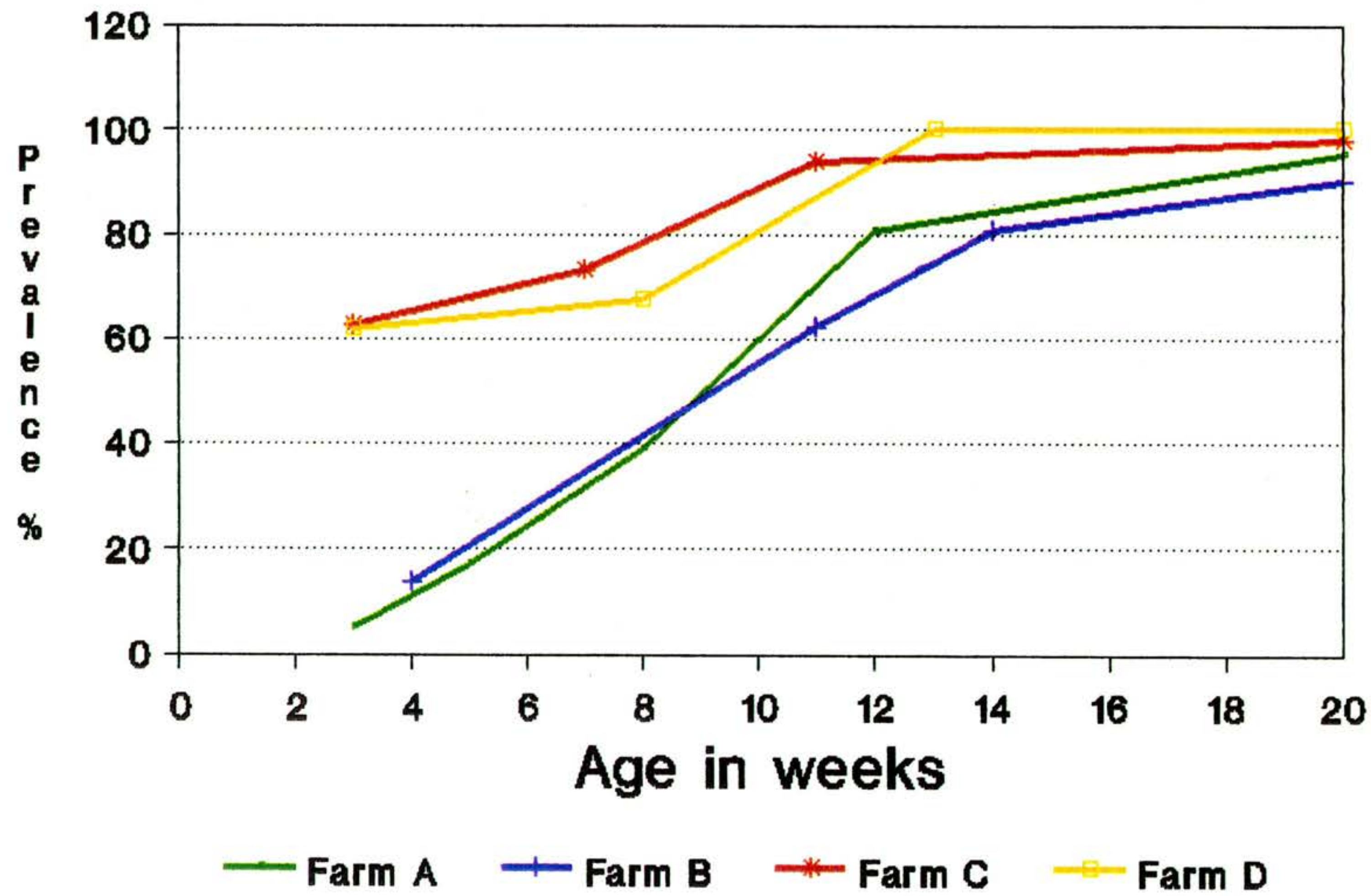
Fig 5.10 The prevalence and severity of bursitis at each successive housing stage



Farm E

Plate 5.6: **Piglets in follow-on pen. The sow has been removed. Note the plentiful supply of straw.**

Fig 5.11 Prevalence of bursitis versus time



Farm Bursitis Study 4

Introduction

While collecting survey data at the abattoir, it was noted that some farms produced finished pigs with two different slap marks and the average bursitis score for the pigs in each slap-mark-group was markedly different. When enquiries were made regarding the housing of these pigs, it was discovered that all the pigs were farrowed and reared to approximately 35-40 kg in the same accommodation within each farm, but then the pigs were randomly split to either conventional intensive type accommodation or to deep strawed courts. However, all finishing pigs were fed the same ration and were tended by the same stockperson in each farm.

Objective

To study the development of bursitis in pigs reared to 35-40 kg in the same accommodation but reared in two different housing systems to 90 kg on the same farm.

Materials and Methods

Four farms were identified from the abattoir survey data and the owners were approached for approval to examine the premises and the pigs. Floors were either placed in hard, intermediate or soft categories as outlined in Chapter 4. In three of the farms (A, B and D) the piglets were farrowed and reared to weaning on hard floors. In the fourth farm (C) piglets spent some time on an intermediate floor of concrete and light straw bedding in the creep area of the farrowing pen. In farm D the pigs spent some time in weaner stage two, in pens with sawdust as bedding. In all four farms, a proportion of the pigs were finished in deep strawed courts. The finishing pigs from each farm were all the offspring of white hybrid sows and Large White or Landrace boars. The type of floor in each housing unit is noted in Table 5.11. Although the pigs were not individually examined at the end of stage 2 (35-40 kg liveweight) a clinical inspection revealed, that many pigs had severe bursitis as would be expected from rearing on hard floors.

Table 5.11: The type of floor in each housing stage in each farm.

Farm		**Floor Type**
A	F/H	Concrete + Expanded Metal
	S1	Plastic Slats
	S2	Concrete + Expanded Metal
	F(A1)	Concrete + Expanded Metal
	F(A2)	Straw Court
B	F/H1	Concrete + Expanded Metal
	or F/H2	Concrete + Woven Wire
	S1	Expanded Metal
	or	
	S1	Plastic Slats
	S2	Concrete + Woven Wire
	F(B1)	Concrete + Concrete Slats
	F(B2)	Straw Court
C	F/H1	Concrete + Straw
	or	
	F/H2	Concrete + Woven Wire
	S1	Concrete + Round Metal Rods
	S2	Round Metal Rods
	F(C1)	Concrete + Concrete Slats
	F(C2)	Straw Courts
D	F/H	Concrete + Expanded Metal
	S1	Expanded Metal+ Concrete/Sawdust
	S2	Concrete + Concrete Slats
	F(D1)	Concrete + Concrete Slats
	F(D2)	Straw Courts

F/H = Farrowing House S1 = Rearing Stage One
F = Finishing Accommodation S2 = Rearing Stage Two

Results

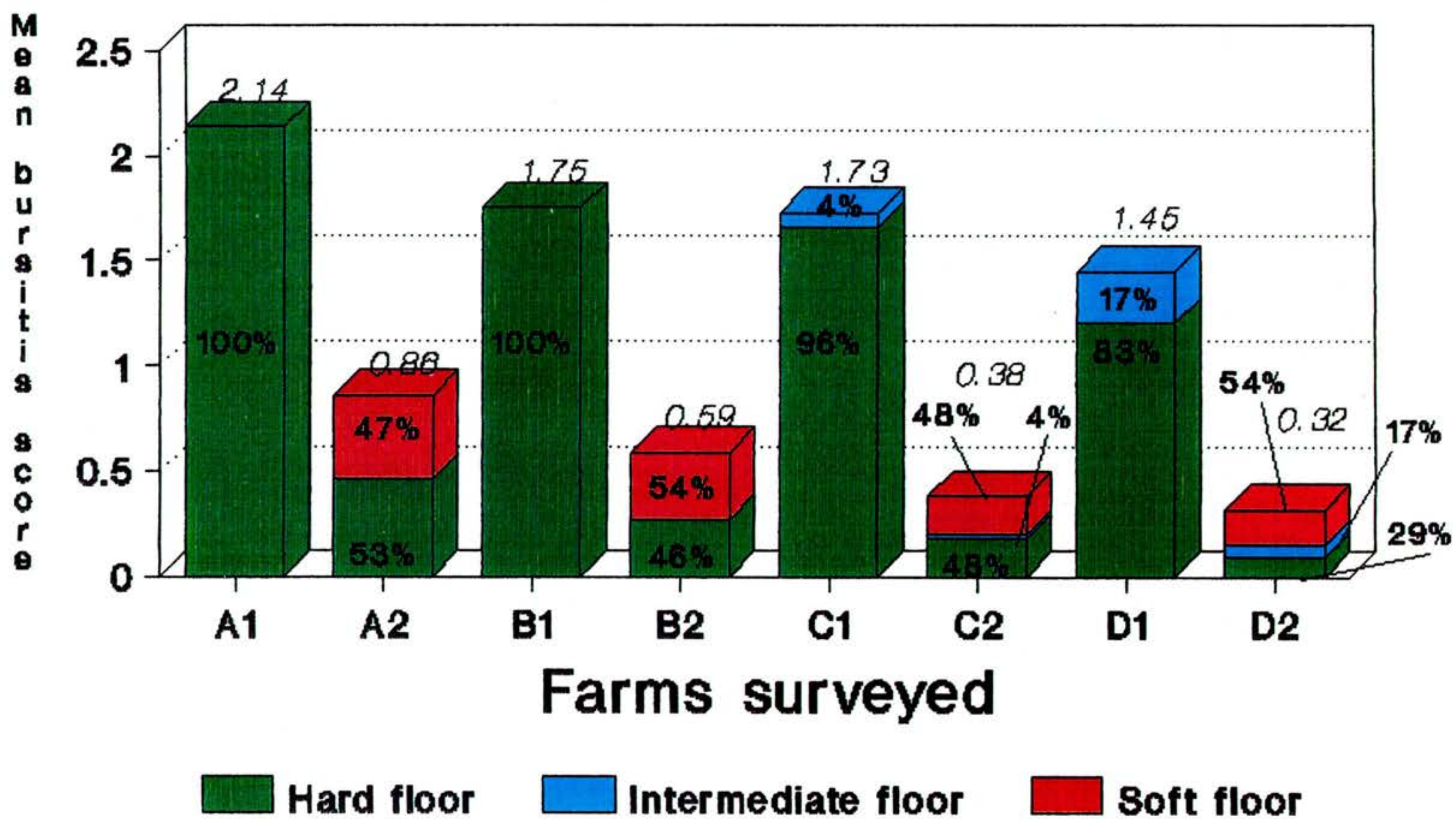
The mean bursitis score for each group of pigs at slaughter from each type of housing is noted in Table 5.12, along with the number of pigs in each group and the approximate amount of time spent on each floor. The mean bursitis scores at slaughter are also shown in Figure 5.12. There is a marked reduction in the prevalence of bursitis and the mean bursitis score between the two groups within each treatment. The combined mean score for pigs which were finished on hard floors on the four farms was 1.77 while the mean score for those finished in deep straw was 0.54 (see Table 5.13).

Table 5.12: The average bursitis score for each group of pigs, the floor type on which they were reared and time spent on each floor type

Farm	Floor type		No. of pigs	Mean bursitis score	% Time		
	birth to 40 kg	40 - 90 kg			Hard floor	Soft floor	Interm. floor
A1	Hard	Hard	157	2.14	100	0	0
A2	Hard	Soft	31	0.86	53	47	0
B1	Hard	Hard	184	1.75	100	0	0
B2	Hard	Soft	57	0.59	46	54	0
C1	Interm/ Hard	Hard	50	1.73	96	0	4
C2	Interm/ Hard	Soft	102	0.38	48	48	4
D1	Hard	Hard	88	1.45	83	0	17
D2	Hard	Soft	87	0.32	29	54	17

interm. = intermediate

Fig 5.12 The mean bursitis score & % time spent on the 3 floor categories



[4 farms - 2 systems per farm]

Table 5.13: The mean bursitis score for pigs either finished on straw or on hard floors on 4 farms.

	Straw bedding	Hard floors
No. of pigs	277	479
Mean bursitis score	0.54	1.77

Discussion

As the pigs were randomly selected at 35-40 kg it seems unlikely that the prevalence and severity of bursitis would have been different between the groups at the beginning of the study. Data collected in Study 3 on other farms showed that pigs reared on hard floors had a significant degree of bursitis by 35-40 kg liveweight. The presence of bursitis might have a serious effect on selection rate. The findings of this study would suggest that producers of breeding gilts and boars could rear the growing pigs intensively and still produce breeding animals with reasonable legs by finishing them on deep straw. The owner of Farm A, which had a lameness problem in finishing pigs, noted that he had to treat fewer animals in the strawed court.

Conclusion

Housing pigs with bursitis on deep straw for the final finishing phase resulted in a marked decrease in severity of bursitis at slaughter.

Farm Bursitis Study 5

Introduction

In the last study it was noted that housing pigs in deep strawed courts in the finishing phase resulted in a reduction in the severity of bursitis at slaughter. This study might determine if bursitis and claw lesions could be prevented completely by rearing pigs on deep bedding from birth to slaughter.

Objectives

1) To study and compare the severity and prevalence of bursitis in pigs born and reared on deep bedding to 90 kg, with pigs born and reared on hard floors in the same farm to the same weight.

2) To study and compare claw lesions in pigs born and reared on deep bedding to 90 kg with pigs born and reared on hard floors in the same farm to the same weight.

Materials and Methods

A farm which consistently produced pigs with high bursitis scores was chosen. In the farrowing house, five farrowing pens, which were adjacent to each other, were selected. In each case, a board, 12 cm high was placed behind the sow and boards were laid on the cast iron slats underneath the sow. This allowed a deep bed of chopped straw and sawdust to be built up, and maintained that way until weaning at 23 days of age.

The piglets were examined for the presence of bursitis and scored in the manner already outlined. Foot lesions were also scored in the usual way at slaughter. A total of 40 pigs was selected (on size) for transfer to deep strawed pens, where they remained until slaughter. These pigs were housed in four groups of 10 at the VI Centre Pig Unit, as the farm had no bedded accommodation for pigs of this age group.

Weaners from the other sows on the farm which had been reared in farrowing pens without bedding, were transferred to the usual intensive accommodation. Data regarding bursitis lesions and foot lesions were collected at slaughter from 100 pigs reared through first and second stage flatdecks (expanded metal), and finally in pens with concrete floors and concrete slatted dunging area. The same data were collected at regular intervals from the pigs reared on deep bedding. Both groups were fed the same diet.

Results

The data collected from each group are presented in Tables 5. 14 (deep bedding) and 5.15 (no bedding).

Table 5.14 The number of pigs examined at each stage and the mean bursitis score.

Age in days	No. of pigs	Mean bursitis score	Prevalence of bursitis (%)	Foot lesion score (mean)
23	40	0	0	0
44	40	0	0	0
65	40	0	0	0
86	40	0	0	0
107	40	0	0	0
128	40	0	0	0
155	39	0.064	7.69	0

Table 5.15: The mean bursitis score, the prevalence of bursitis and the foot lesion score at slaughter

Age in days	No. of pigs	Mean bursitis score	Prevalence of bursitis (%)	Mean Foot-rot score
23	60	0.76	64.04	0.31
159	51	2.110	91.06	2.4

In the bedded group, three male pigs showed evidence of bursitis at slaughter, with a combined mean score of 0.064. There was no evidence of these bursae when the pigs were examined on day 128. In the farrowing house with deep bedded pens, the atmosphere became objectionable because of the ammonia from the urine which had soaked into the sawdust, despite twice daily removal of dung.

During the last two weeks of finishing, the diurnal temperature rose markedly and the pigs became quite stressed. Some were successful in rooting down through the straw to make a wallow near the nipple drinker in spite of determined efforts by the stockman to keep the concrete covered. The pigs with bursae were three of the largest and strongest, and were able to maintain their position in the wallow for longest. The claws of all the pigs in this group were normal and the most striking feature, apart from the absence of lesions, was the pale appearance of the soles of the feet. In addition, there was no evidence of bursal lesions on other areas of the hock or on the forelegs. One pig died with typical signs of the Porcine Stress Syndrome while being loaded. Signs of stress, including skin veining as described by Penny and Guise (1988), were noted while handling this pig (see Plate 5.7). In the pigs reared intensively, the mean foot-rot score rose markedly from 0.31 to 2.4. The concrete in the pens was not unduly abrasive, while the slats were well made.(round pencil edge and no chips) They were 10 cm wide with a 2 cm gap. A high prevalence of foreleg bursae was noted in the pigs reared intensively, but these were not individually counted. Of the 60 pigs which remained on the farm, nine went "missing" by slaughter (dead or tag missing) The remaining 51 had a marked level of bursitis and foot-rot lesions at slaughter.

Discussion

These findings would indicate that bursitis can be eliminated completely by rearing pigs from birth on deep straw bedding, provided that a reasonable depth of bedding can be maintained, but this is often difficult to achieve. The ammonia problem can now be avoided by utilising the enzyme-driven deep litter system pioneered in Japan (McCormick 1990). However, this system is used without farrowing crates and had to be abandoned on one farm in the North-East of Scotland because of high mortality in the piglets. (Davidson, 1990). Thus, great care must be taken to ensure that the solution to one problem does not cause another. It was also noticed that lesions of teat necrosis and knee necrosis were entirely absent in pigs weaned off the deep shredded farrowing pens.

Overall Conclusion

Suckling pigs can develop bursitis in the first week of life if reared on hard floors (see Plate 5.8). The formation of bursae at this age is usually preceeded by depilation of the area of skin under which the bursae forms. Even when reared in farrowing rooms with floors which give rise to low levels of bursitis, pigs will rapidly develop severe bursitis on very hard floors, to the same extent as their contemporaries reared on hard floors from birth. Therefore, farmers who wish to avoid bursitis in their finishing pigs will not be able to do so by simply providing kinder conditions in the farrowing rooms alone.

Study 4 showed that the prevalence and severity of bursitis could be markedly reduced by housing pigs on a softer floor from 35-40 kg liveweight onwards. This improvement would probably satisfy the standards required for the selection of breeding animals by most pig breeding companies. However, should the complete absence of bursitis be demanded by welfare codes or any other form of legislation, it is highly probable that this could only be achieved by rearing pigs on very soft floors from birth as shown in Study 5.

It was decided to examine the welfare aspect in more detail and this is described in Chapter 6.

Plate 5.7: Note distension of veins and blotchy discolouration of the skin due to filling of capillaries with anoxic blood.

Chapter 6

BURSITIS : HIGH WELFARE SYSTEMS

The purpose of this study was to examine the effect of high welfare systems on pigs with some degree of bursitis. An opportunity arose to collect data from pigs which themselves were being used to assist in the development of these systems and were the subject of behavioural studies.

Objectives

1) To study the development of bursitis in the Straw-Flow System.
2) To study the development of bursitis in the Enzyme/ Sawdust Deep Litter System.
3) To study the development of bursitis in a deep straw system.
4) To compare the development of bursitis in both high-welfare systems and intensive systems in the same environment.

Study 1

Straw-Flow Trial

Introduction

The Straw-Flow System (SFS) was described as a "*novel high-welfare system*" and was developed at the Centre for Rural Buildings, Craibstone, Aberdeen (Bruce, 1990) and has been patented. It was stated that the main objective of developing the system was to improve the welfare of the pigs in a way which recognised the need for acceptability to agriculture. The welfare benefits for the pigs are "*improved warmth, mechanical comfort and grooming and the opportunity for rooting and recreational behaviour*". (Anon 1989)

In the system, straw is supplied at a daily rate of 100 g per pig from a self-help hopper from which the straw is removed by the pigs at a more or less controlled rate. The pen floor is sloped (1:16) into a dunging channel with a step down (100 mm) (see Figure 6.1

and Plate 6.1). The straw flows down the slope under the action of gravity and the activity of the pig. The dung is removed by a manual scraper. The development of the Straw-Flow System was supported by a grant from the RSPCA, implying a welfare component within the system.

Objective

To study the prevalence and severity of bursitis in pigs reared from 8.37 kg (mean weight) to slaughter (85-90 kg) in a Straw-Flow System.

Materials and Methods

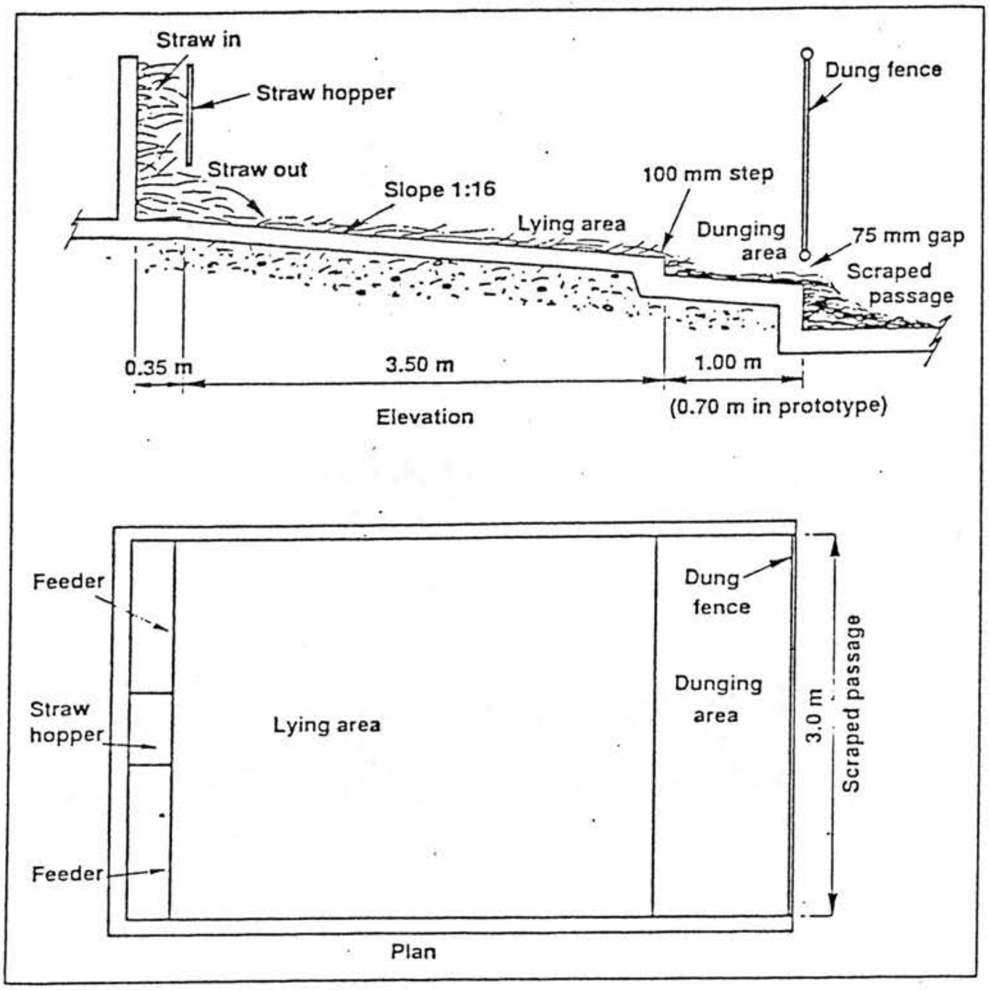
Pigs (38) from 4 gilts on a "once bred gilt" trial (Fowler, 1990) were weaned directly into a Straw-Flow Pen.(Pen 1) The total number of pigs in the pen was made up to 50 by taking 12 weaners from the same farm where the litters of the gilts were reared. The pen dimensions were as shown in Figure 6.1. On day 42, the pigs in pen 1 were reduced in number by half. The 25 pigs removed were placed in a similar Straw-Flow pen of the same dimensions apart from the dung passage which was 1 metre wide. (Pen 2) All the pigs were again weighed and any bursaw present were scored in the usual fashion. After 35 days, when the pigs had reached approximately 75 kg, five pigs were removed from each pen and slaughtered (mean weight 75.8 kg). After 59 days the remaining pigs were slaughtered at a mean weight of 84.78 kg. The pigs in each pen were weighed and bursae on either leg were scored in the usual fashion, on entry to the system, 42 days later and on the day before slaughter.

The correlation between the rate of growth (DLWG) and the development of bursitis was examined 42 days after the first examination. With regard to these pigs which already had bursitis at the beginning of the trial, only the increase in the severity of bursitis was recorded.

Statistical Analysis

The data were analysed by analyis of variance and regression analysis.

Plate 6.1: **A Straw-Flow pen with pigs. Note the straw hopper (arrow 1) and the feed hopper (arrow 2)**



Details of Straw-Flow pen design.

Figure 6.1: Details of the Straw-Flow pen.

Results

The number (tattoo) of each pig, the weight, sex and bursitis score for each leg at the first examination is noted in Table 6.1. At this point all the pigs were in pen 1.

Table 6.1: The tattoo number, sex, weight and bursitis score of each pig.(n = 50)

Tattoo No.	Sex	Weight (kg)	Bursitis Score Score L	Score R
5950	F	9	0	0
5951	F	8	0	0
5953	M	10	0	dep.
5954	F	10	0	0
5955	F	9	dep.	dep.
5956	F	10	dep.	dep.
5957	M	9	dep.	1
5958	F	7.5	1	1
5959	M	10	0	0
5960	F	10	dep.	dep.
5961	F	10	dep.	dep.
5962	M	7.5	dep.	dep.
5963	F	8.5	dep.	dep.
5967	M	8	dep.	dep.
5987	M	6.5	dep.	dep.
5969	M	7.5	dep.	dep.
5970	F	10.5	dep.	dep.
5971	M	7	dep.	dep.
5972	F	8	dep.	dep.
5974	F	9	dep.	dep.
5975	F	8.5	0	0
5976	M	9.5	dep.	dep.
5977	F	9.5	dep.	0
5978	F	8.5	dep.	dep.
5979	F	11	dep.	dep.

Table 6.1(Contd.): The tattoo number, sex, weight and bursitis score of each pig.

Tattoo No.	Sex	Weight (kg)	Bursitis Score Score L	Score R
5981	M	7.5	dep.	dep.
5982	M	8.5	dep.	dep.
5984	M	8.5	dep.	dep.
5985	M	7.5	dep.	dep.
986	M	7	dep.	dep.
5989	M	6.5	dep.	dep.
5991	F	8	1	0
5992	M	8	0	0
5993	M	8	dep.	dep.
5994	M	8	0	0
5995	M	8	0	0
5996	F	9.5	0	0
5997	M	7	0	0
6000	M	9.5	dep.	dep.
6012	F	8.5	2	1
6090	F	8.5	dep.	dep.
6103	M	7.5	0	0
6104	M	9	2	0
6105	M	8	2	2
6106	M	9.5	1	1
6107	M	7.5	0	0
6108	M	6.5	dep.	dep.
6113	M	6	1	dep.
6117	F	5	2	2
6702	M	9	1	1
Total		**418.5**	**13**	**9**
Mean		**8.37**	**0.22**	

L = Left leg R = Right leg dep. = Depilation of skin

Thus 28 pigs (56%) had no evidence of bursitis but did have evidence of depilation over the plantar or lateroplantar area of the hock. Of the 12 pigs (24%) with no hock lesions, 4 were female and 6 were male and their mean weight was 8.42 kg which was above average for the group. Only 10 pigs (20%) had evidence of bursitis, with a mean score of 0.22 and two of them had a bilateral score of 2. The tattoo number of each pig, weight, sex and bursitis score on each leg are shown in Tables 6.2 and 6.3 and the weight and increase in bursitis score for each pig are noted in Table 6.9.

Table 6.2: The tattoo number, sex, weight and bursitis score of each pig. (Pen 1)

Tattoo No.	Sex	Weight (kg)	Bursitis Score Score L	 Score R
5950	F	39.5	2	2
5951	F	37	0	0
5954	F	39	1	0
5955	F	37.5	2	2
5960	F	37	2	1
5961	M	35	2	2
5971	M	36	1	1
5972	F	32.5	1	1
5975	F	31.5	0	0
5977	F	30.5	1	0
5979	F	40.5	0	0
5981	M	36	1	0
5982	M	35	0	0
5991	F	31	2	2
5992	M	36	0	0
5993	M	35.5	0	0
5994	M	37.5	1	1
5996	F	38	2	3
5997	M	35	1	2
6000	M	43	1	0
6090	F	31.5	1	1
6104	M	30	3	1
6105	M	30.5	2	2
6106	M	36	2	3
6108	M	27.5	0	0
Total		**878.5**	**28**	**24**
Mean		**35.14**	**1.04**	

L = Left leg R = Right leg

Table 6.3: The tattoo number, sex, weight and bursitis score of each pig. (Pen 2)

Tattoo No.	Sex	Weight (kg)	Bursitis Score Score L	Score R
5953	M	35	0	0
5956	F	36.5	2	1
5957	M	33	3	3
5958	F	35	2	2
5961	F	40.5	1	2
5962	M	36	1	1
5963	F	31	2	1
5967	M	34.5	1	1
5969	M	30.5	1	1
5970	F	36	1	1
5974	F	35	2	2
5976	M	38	1	1
5978	F	35.5	1	0
5984	M	37	0	0
5985	M	34	0	0
5986	M	32	0	0
5987	M	34	0	0
5989	F	30.5	1	1
5995	M	36.5	0	0
6012	F	35	2	2
6107	M	29	1	2
6102	M	33	2	2
6103	M	34	2	0
6113	M	24.5	2	1
6117	F	30	2	2
Total		**846.0**	**30**	**26**
Mean		**33.84**	**1.12**	

L = Left leg   dep. = depilation of skin

R = Right leg

The combined mean weights and bursitis scores are shown in Table 6.4.

Table 6.4: The combined mean weight and bursitis score for the pigs in Pens 1 & 2

Number of Pigs	50
Mean Weight (kg)	34.49
Mean Bursitis Score	1.08
DLWG	622 g

DLWG = mean daily liveweight gain

At the second examination on day 42, when the pigs had reached a mean weight of 34.49 kg, the prevalence and severity of bursitis had risen considerably. In pen 1, the original pen, the number of pigs affected had risen to 18 (72%) while the mean severity score had risen to 1.04. In pen 2, the number of pigs affected had risen to 19 (76%), while the mean bursitis score was 1.12. In pen 1, three pigs had at least one bursa with a score of 3 while in pen 2, one pig had a bursa with a score of 3. One pig, 5996, with a score of 2 and 3 on the left and right leg respectively, had a double zero score at the first examination. Careful observation of this pig revealed no particular behavioural trend which would explain the rapid development of this degree of bursitis.

After 35 days, of the five pigs from pen 1, four had bursitis and the mean score was 1.2 while three of the pigs from pen 2 had bursitis with the mean score of 0.7 (combined mean score 0.95) (see Table 6.5). The mean score for those ten pigs at the second examination was 0.9, so the increase was only marginal. These were the biggest pigs in the pen. The data collected after 59 days are noted in Tables 6.6 and 6.7.

Table 6.5: The tattoo number, sex, weight and bursitis score of the 10 pigs removed for slaughter.

Tattoo No.	Wt.(kg)	Sex	Bursitis Score L	Bursitis Score R	Pen No.
5950	76	F	1	1	1
5993	74	M	0	0	1
5996	76	F	2	2	1
6000	82	M	1	1	1
6106	75	M	2	2	1
		Mean Score =	1.2		
5953	79	M	0	0	2
5976	74.5	M	2	2	2
5984	75	M	0	0	2
5995	76	M	1	0	2
6103	71	M	2	0	2
		Mean Score =	0.7		

Table 6.6: The tattoo number, weight, sex and bursitis score of each leg (Pen 1)

			Bursitis Score	
Tattoo No.	**Sex**	**Weight (kg)**	**Score L**	**Score R**
5951	F	94	0	0
5954	F	82	0	0
5955	F	90	2	2
5960	F	83	2	2
5961	M	92.5	1	0
5971	M	92	2	3
5972	F	81	3	1
5975	F	79	0	0
5977	F	82	2	1
5979	F	90	0	1
5981	M	84.5	2	2
5982	M	92.5	0	0
5991	F	81	2	3
5992	M	91	0	0
5994	M	95	1	1
5997	M	88	1	2
6090	F	85	1	1
6104	M	75	3	2
6105	M	80	3	3
6108	M	81.5	0	0
Total		1719	25	24
Mean		85.95	1.225	
DLWG		861 g		

L = left leg DLWG = daily liveweight gain

R = right leg

Table 6.7: The tattoo number, weight, sex and bursitis score of each leg (Pen 2).

			Bursitis Score	
Tattoo No.	**Sex**	**Weight (kg)**	**Score L**	**Score R**
5956	F	75	2	1
5957	M	90	2	2
5958	F	89	3	2
5961	F	85	1	3
5962	M	90	1	1
5963	F	78	2	1
5967	M	88	1	2
5969	M	87	2	1
5970	F	81.5	1	1
5974	F	82	2	2
5978	F	83	1	1
5985	M	81	1	1
5986	M	85	0	0
5987	M	87	0	0
5989	F	75	1	1
6012	F	82.5	2	2
6102	M	95	2	2
6107	M	81.5	1	2
6113	M	79.5	3	3
6117	F	77	2	2
Total		1672	31	30
Mean		83.6	1.525	
DLWG		843 g		

L = left leg DLWG = daily liveweight gain

R = right leg

In pen 1, 14 pigs (70%) were affected with bursitis and the mean score was 1.225. This score was only slightly higher than the score at the previous examination but it should be noted that 5 pigs with a mean score of 1.2 had already been removed from the pen. In pen 2 18 pigs (90%) showed evidence of bursitis with a mean score of 1.525. Although this score was much higher than the score in pen 1, the 5 pigs removed earlier had a mean score of only 0.7.

The data collected at each examination have been summarised in Table 6.8 and Figure 6.2.

Table 6.8: The number of pigs, the mean bursitis score, the number of pigs affected and mean weight at each examination.

Examination	No. of pigs	Mean score	Prevalence (%)	Mean weight(kg)
1	50	0.22	20	8.37
2	50	1.08	74	34.49
3	10	0.95	70	75.85
4	40	1.38	80	84.78

Indeed, one pig number 5974, with bilateral bursae (score 2) had a small erosion on each bursa. The time interval between the first and second examination was 42 days and the daily liveweight gain was 622 g.

Discussion

The main increase in the prevalence and severity of bursitis took place during the time all the pigs were housed in pen 1. The stocking density in pen 1, on the last day, when 50 pigs were present, was 123 kg/m^2 while the stocking density in pens 1 and 2 was 136.7 kg/m^2 (25 pigs/pen) and 136.4 kg/m^2 on the day before slaughter (20 pigs/pen). The stocking density was less during the period of rapid bursal development. However, both stocking densities were above these recommended in the Codes of Recommendations for the Welfare of Livestock (Pigs, 1968) which states that "*stocking density should not exceed 120 kg/m^2 for this weight of pig*". It is likely that the high stocking density in the first housing stage helped to increase the severity of bursitis to such an extent that even higher stocking densities later in life had comparatively less effect. The presence of a step (100 mm) to the dung pass may have also played a role in the development of bursitis in the study. Penny (1981) suggested that a sill to the bedded area or a step down to the dunging area might play an important precipitating role.

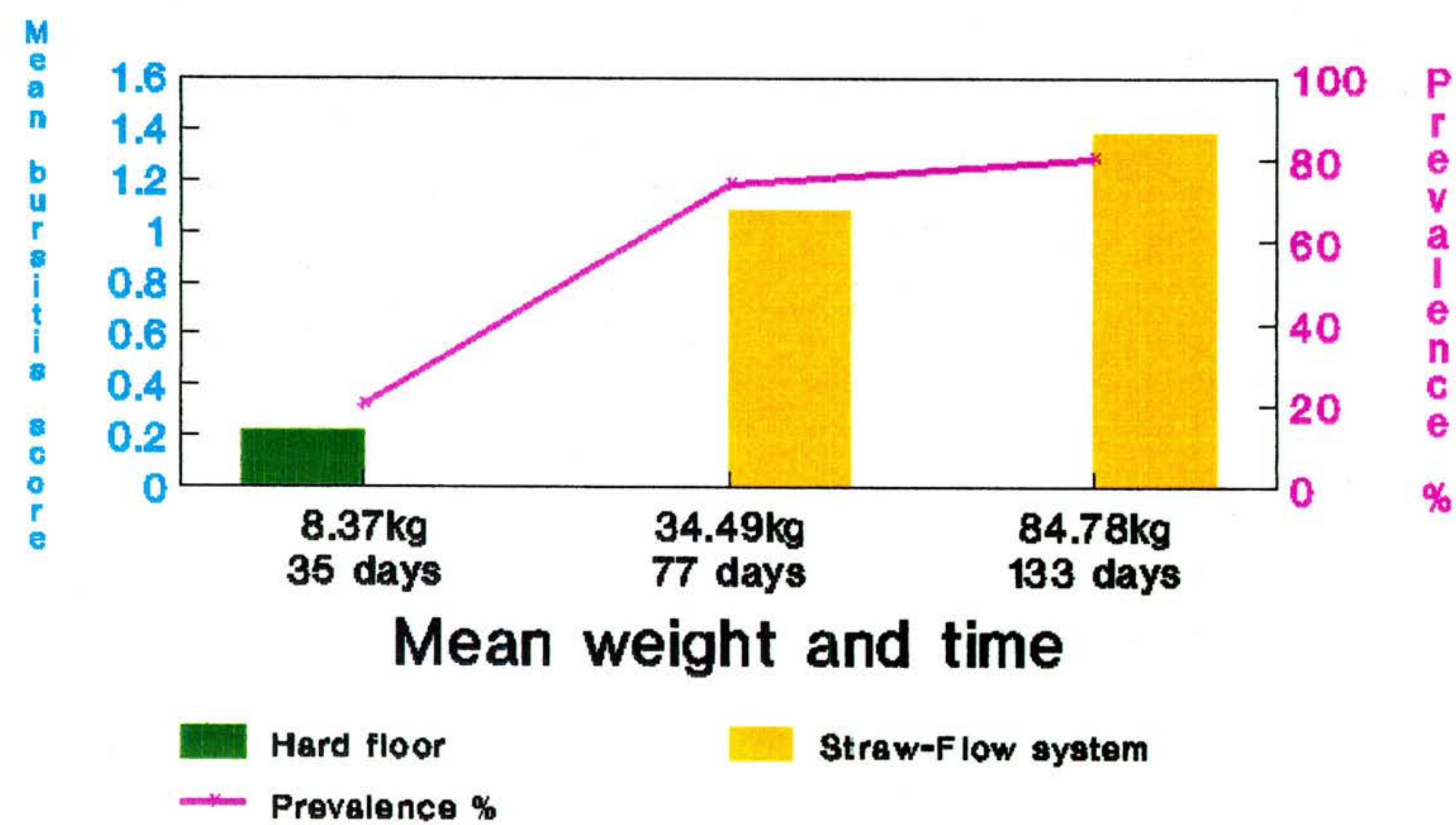
Table 6.9: The pig number, weight gain and increase in bursitis score.

Tattoo No.	Weight gain	Bursitis score increase
6000	33.5	0.5
5950	30.5	2
5961	30.5	2
5994	29.5	0.5
5951	29	0
5954	29	0.5
5971	29	1
5955	28.5	2
5962	28.5	1
5976	28.5	1
5981	28.5	0.5
5984	28.5	0
5995	28.5	0
5996	28.5	2.5
5992	28	0
5997	28	1.5
5958	27.5	1
5987	27.5	0
5993	27.5	0
5960	27	1.5
5974	27	2
5978	27	0.5
5956	26.5	1.5
5967	26.5	1
5982	26.5	0

Table 6.9 (Contd.)

Tattoo No.	Weight gain	Bursitis score increase
5985	26.5	0
6012	26.5	0.5
6103	26.5	1
6106	26.5	1.5
5970	25.5	1
5961	25	2
5986	25	0
6117	25	0
5953	25	0
5972	24.5	1
5979	24	0
5989	24	1
6102	24	1
5969	23	1
5975	23	0
5991	23	1.5
6090	23	0.5
5963	22.5	1.5
6105	22.5	0
5957	22	2.5
6107	21.5	1.5
5977	21	0.5
6104	21	1
6108	21	0
6113	18.5	1

Fig 6.2 The mean bursitis score and prevalence of bursitis for pigs reared on the Straw-Flow system



Analysis of variance showed no relationship between the bursitis score and rate of gain ($p > 0.05$).

The regression equation was:

Wt gain	=	25.9 + 0.177 bs
bs	=	bursitis score

The rate of usage of straw was kept constant during the growth period so bedding was not a factor. It has been shown that the prevalence and severity of bursitis increases as pigs grow from 20 to 90 kg (Backstrom and Henricson, 1966, Nielsen, 1988). There was no correlation between the rate of growth and the severity of bursitis in the 50 pigs observed in this study. Indeed, the liveweight gain and mean bursitis score of the ten heaviest pigs was 1140 g/day and 0.95 respectively, while the growth rate and mean bursitis score of the remaining pigs was 852 g/day and 1.38 respectively. Other studies have also failed to show a relationship between bursitis and growth rate (Backstrom and Henricson, 1966, Berner et al 1990). One of the proclaimed benefits of the Straw-Flow system is the improvement in the welfare of the pigs. There is no doubt that investigative behaviour and rooting is better cared for in such a system. However, if the development of subcutaneous bursae, which is a direct sequel to lying on hard floors, is taken as a marker of welfare, then the system as it was run in this study failed, as there was a progressive increase in the prevalence and severity of bursitis. However, it could be argued that the provision of more bedding, would have prevented bursitis arising to the same extent. The mean bursitis score for those pigs which remained in intensive housing on the farm was 2.12 and it is highly likely that if the pigs in the Straw-Flow trial been reared on the farm in the same housing system, their mean bursitis score would have been similar.

Conclusion

In a Straw-Flow system, 40 pigs out of 50 began a trial with no bursitis. Of these, 29 (72.5%) developed bursitis with a mean score of 1.41. (the mean score of 14,046 pigs in the abattoir survey was 1.598) There was no relationship between the severity of bursitis and weight gain. The rate of development of bursitis was greatest during the first six weeks in the system. If the absence of bursitis is regarded as a measure of good welfare, the Straw-Flow system was only a partial success.

Study 2

Enzyme-Sawdust-Deep Litter System

Introduction

The system was first introduced in Japan and has been taken up by pig producers in at least 12 different countries (Anon, 1990). The enzyme mixture which is responsible for making the system work, has been produced by a number of companies. Although recommendations vary, the system is started by adding the enzyme mixture to a 600 mm bed of sawdust on a solid concrete base before the pigs enter the pen. Then at 7-14 day intervals more of the mixture is added as the top surface of the bed is buried or mixed in with the layer below.(see Plate 6.2) This allows the bio-system to degrade the dung and at the same time to aerate the bed which is important. When the system works well, several batches of pigs can be housed in succession without having to muck out. At the same time the aerial environment is improved because of the reduction in production of ammonia, which is either bound by the bacteria or converted to amines or protein. There is a significant production of heat due to fermentation and at a depth of 200 mm the bed may be $6^{o}C$ higher than the surface. Taste panel tests have shown that, where there is preference, it is in favour of pork from pigs reared on the enzyme/sawdust system. Another useful spin off is the welfare element, because of the use of deep bedding and lower stocking rate of around 1 m^2/pig at 90 kg (Anon, 1990). An adaptation of the system was reported by Gadd (1991) in which the enzyme mixture was supplied in the feed and pigs mixed the bed themselves.

Objective

To study pigs with and without bursitis on an enzyme/sawdust/deep litter system.

Material and Methods

Two deep sawdust pens which were being used for research and development studies were used and 10 pigs were placed in each pen. Pigs were purchased around 40-50 kg from a farm where they had been reared intensively, and the hocks were scored for bursitis on entry to the pens, in the usual manner and the pigs were weighed. The pigs were examined on four occasions; on day 1, day 21, day 35 and day 56 with the last observation being made on the day before slaughter.

In a second behavioural study, nine pigs were placed in each pen. The pigs had been reared intensively on hard floors to approximately 30 kg liveweight. On entry to each pen, each pig was weighed and any bursae present were scored in the usual way. Unfortunately, the behavioural study had to be abandoned shortly after the second examination of the pigs was carried out, a month after the trial began.

Results

The data collected from the pigs in the first behavioural study are presented in Tables 6.10-13 while these data collected from the second behavioural study are noted in Tables 6.14 and 6.15.

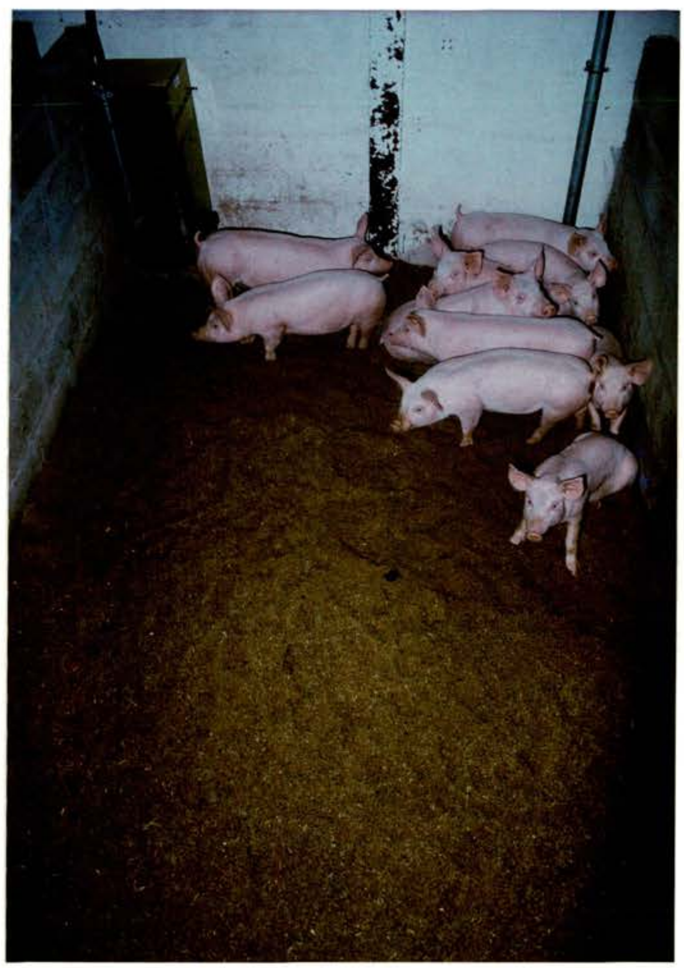


Plate 6.2: Pigs on a deep sawdust/enzyme/system

Table 6.10: The pig number, sex, weight and bursitis score at the first examination (day 1)

Pig No.	Weight kg	Sex	Bursitis Score L	Bursitis Score R
Pen A				
101	43	F	2	1
102	37	M	2	3
103	34	F	2	1
104	50	F	2	2
105	40	F	2	1*
106	42	M	3	3
107	42	F	2	1
108	40	F	2	3
109	41	F	2	2*
110	40	M	2	1
Pen B				
201	52	F	2	2
202	50	F	0	0
203	47	F	2	2
204	40	F	1	1
205	51	M	1	1
206	38	M	2	2
207	50	F	2	1
208	41	M	1	2
209	35	F	1	1
Total	815.1			
Mean	42.9		1.64	
Prevalence	94.74%			

* = bursae present on medial aspect.

Pig number 110 was discarded from the trial because of arthritis of the right hock joint.

Table 6.11: The pig number, weight, sex and bursitis score at the second examination (day 21).

Pig No.	Weight kg	Sex	Bursitis Score L	R
Pen A				
101	62	F	1	1
102	54	M	0	1
103	42	F	1	0
104	60	F	2	1
105	56	F	2	1
106	61	M	2	2
107	59	F	2	1
108	57	F	1	1
109	58	F	0	0
Pen B				
201	65	F	0	1
202	60	F	0	0
203	60	F	2	1
204	51	F	1	0
205	64	M	0	1
206	52	M	1	1
207	65	F	1	0
208	57	M	1	1
209	53	F	0	0
Total	1031			
Mean	57.28		0.805	
Prevalence	88.89%			

Table 6.12: The pig number, weight, sex and bursitis score at the third examination (day 35).

Pig No.	Weight kg	Sex	Bursitis Score L	Bursitis Score R
Pen A				
101	70	F	0	1
102	57	M	0	0
103	60	F	0	0
104	67	F	0	0
105	70	F	0	0
106	67	M	1	0
107	66	F	0	0
108	64	F	0	0
109	67	F	0	0
Pen B				
201	73	F	0	0
202	65	F	0	0
203	66	F	0	0
204	66	F	0	0
205	67	M	0	0
206	61	M	0	0
207	73	F	0	0
208	65	M	0	0
209	64	F	0	0
Total	1188			
Mean	66.0		0.028	
Prevalence	5.56			

Table 6.13: The pig number, weight, sex and bursitis score at the fourth examination (day 56).

Pig No.	Weight kg	Sex	Bursitis Score L	Bursitis Score R
Pen A				
101	92	F	0	0
102	75	M	0	0
103	80	F	0	0
104	87	F	0	0
105	88	F	0	0
106	75	M	0	0
107	86	F	0	0
108	75	F	0	0
109	87	F	0	0
Pen B				
201	96	F	0	0
202	81	F	0	0
203	86	F	0	0
204	87	F	0	0
205	91	M	0	0
206	82	M	0	0
207	93	F	0	0
208	87	M	0	0
209	84	F	0	0
Total	1531.98			
Mean	85.11		0	
Prevalence	0.2%			

Although there was a high prevalence of bursitis (94.44%) at the beginning of the trial, the severity of bursitis was not high (1.33) and the bursae were all of the soft fluctuating type.

There was a dramatic drop in the prevalence and severity of bursitis on the deep sawdust, especially in the first month of occupation. (see Figure 6.3) The improvement noted in the sawdust bedded pigs was much greater than that seen on deep straw systems.

Table 6.14: The bursitis score, weight, sex and number of each pig at the first examination (day 1).

Pig No.	Weight kg	Sex	Bursitis Score L	Bursitis Score R
Pen A				
1	30	F	1	1
2	31	F	2	2
3	32	F	1	0
4	29	F	1	2
5	30	M	2	2
6	32	M	1	1
7	31	F	3	3
8	26	F	1	2
9	30	F	1	0
Total	270.99			
Mean	30.11		1.44	
Pen B				
1	39	F	1	1
2	29	M	2	2
3	31	F	2	1
4	27	F	2	2
5	25	F	1	0
6	30	M	0	0
7	27	M	1	1
8	30	F	2	2
9	27	F	1	1
Total	264.96			
Mean	29.44		1.22	

Prevalence of bursitis (Pens A and B) = 94.45%

Fig 6.3 The mean bursitis score & prevalence of bursitis for pigs reared on the deep-sawdust-enzyme-system

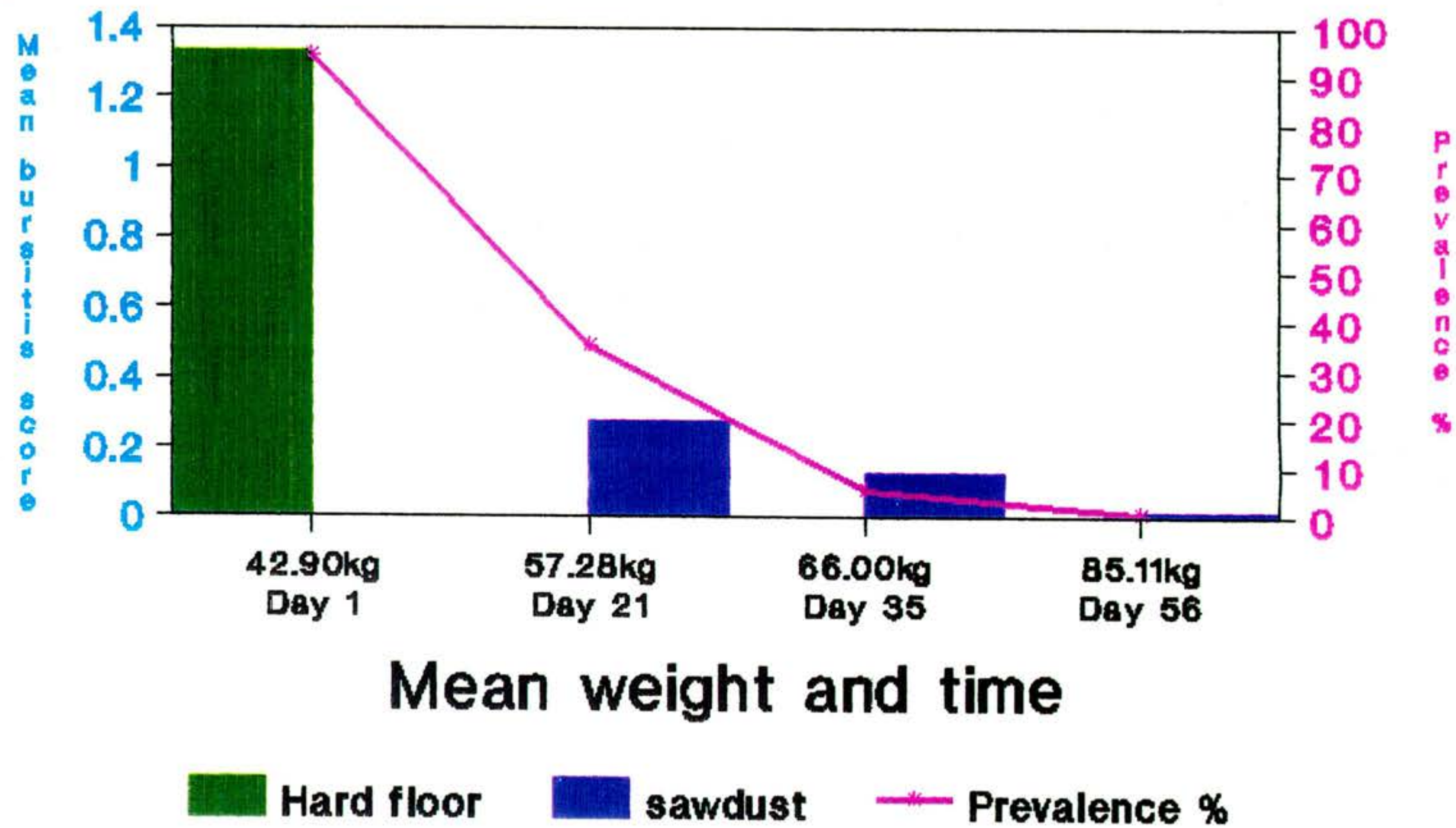


Table 6.15: The bursitis score, weight, sex and number of each pig at the second examination (day 25).

Pig No.	Weight kg	Sex	Bursitis Score L	R
Pen A				
1	54	F	0	0
2	56	F	0	0
3	52	F	0	0
4	55	F	0	0
5	41	M	1	0
6	56	M	0	0
7	56	F	1	0
8	48	F	0	0
9	51	F	0	0
Total	468.99			
Mean	52.11		0.11	
Pen B				
1	57	F	0	0
2	47	M	1	1
3	56	F	1	1
4	58	F	1	1
5	49	F	0	0
6	55	M	0	0
7	47	M	0	0
8	51	F	1	1
9	52	F	0	0
Total	471.96			
Mean	52.44		0.44	

Prevalence of bursitis (Pens A and B) = 33.33%

In the second behavioural trial the mean bursitis score of both groups at the beginning of the trial was 1.33 and 31 days later the mean score had fallen to 0.275, an improvement of almost fivefold. However, pigs 4 and 5 in pen B had bilateral bursae which were hard and it is highly unlikely that a zero score would have been reached in this case. During the 31 days the prevalence of bursitis in the 18 pigs (A + B) fell from 94.45% to 33.33%.

Conclusion

The deep sawdust-enzyme-system was extremely efficient at reducing bursitis in growing pigs.

Study 3

Deep Straw System

Introduction

It is generally recognised that the general public believe that deep straw systems provide a high welfare environment for the pig and this is probably true as far as foot and leg conditions are concerned.

Objective

To study the effect of deep straw bedding on pigs with and without bursitis.

Materials and Methods

The pigs were placed in four deep-strawed pens for behavioural studies. Again these pigs had been reared intensively on hard floors and had a degree of bursitis on arrival. All the pigs were fed the same ration *ad libitum* from hoppers. The number of pigs placed in each of pens A and B was always 8 while 7 pigs were always placed in each of pens C and D. Three trials were completed. Bursitis was scored in the usual manner as the pigs were weighed when they entered the pens. The pigs were then weighed and scored for bursitis on five subsequent occasions in the first two replicates and on four subsequent occasions in the third replicate.

Results

The data collected relating to weight and bursitis score are noted in Table 6.16 and Appendix 6.1.

Table 6.16: The number of pigs, mean weight, mean bursitis score, prevalence of bursitis and day of examination in each group in pens A, B, C and D.

Examination No.		No. of pigs	Mean weight	Mean bursitis score	Prevalence of bursitis
Trial 1					
1	Day 1	30	20.33	1.233	93.3
2	Day 15	30	33.1	0.933	80.0
3	Day 25	30	45.4	0.817	76.6
4	Day 49	30	64.03	0.717	70
5	Day 70	30	80.4	0.650	63.3
6	Day 90	30	96.43	0.517	53.3
Trial 2					
1	Day 1	30	16.35	0.859	66.7
2	Day 15	30	27.32	0.603	53
3	Day 30	30	39.51	0.330	36.6
4	Day 50	29	58.01	0.246	27.6
5	Day 71	29	73.36	0.246	27.6
6	Day 86	29	89.86	0.192	20.7
Trial 3					
1	Day 1	30	30.04	1.547	93.3
2	Day 19	29	45.5	0.739	68.97
3	Day 28	29	56.45	0.437	51.7
4	Day 53	29	78.3	0.281	37.9
5	Day 68	29	94.3	0.192	24.1

In all three trials there was a marked fall in the prevalence and severity of bursitis even though the pigs were all growing rapidly. Thus 42.86%, 70.0% and 74.07% of pigs with bursitis in trials 1, 2 and 3 respectively recovered completely during the study (see Table 6.17). An accumulated analysis of deviance showed that the slope of recovery was mainly linear. One pig died in Trial 2 and one pig was removed from Trial 3 because of rectal prolapse. The data collected from all three trials have been summarised and presented in Table 6.18 and Figures 6.4 and 6.5.

Table 6.17: The number of animals with bursitis at the beginning of each period and the reduction in the prevalence and severity of bursitis.

Examination No.	No. of pigs with bursitis	% of pigs recovered	Reduction in severity
Trial 1			
1	28	0.00	0.00
2	24	14.29	0.300
3	23	4.17	0.117
4	21	8.70	0.117
5	19	9.52	0.050
6	16	15.79	0.133
Total		**42.86**	**0.717**
Trial 2			
1	20	0.00	0.00
2	16	20.0	0.267
3	11	31.25	0.267
4	8	27.27	0.083
5	8	0.00	0.000
6	6	25.00	0.050
Total		**70.00**	**0.667**
Trial 3			
1	27	0.00	0.00
2	20	25.93	0.810
3	15	25.00	0.293
4	11	26.67	0.155
5	7	36.36	0.086
Total		**74.07**	**1.345**

Table 6.18: The number of pigs, mean bursitis score, prevalence of bursitis and mean weight in trials 1, 2 and 3.

No. of Pigs	Mean Score	Prevalence of Bursitis %	Mean weight kg
Start 90	1.213	4.43	22.36
Finish 88	0.300	2.67	93.53

Discussion

It was thought that fewer pigs recovered from bursitis in Trial 1 because many of the bursae were hard at the beginning of the trial. In order to achieve the success demonstrated in this study straw depth has to be considerably more than that used in the Straw-Flow System. In fact the straw should probably be deep enough to prevent the pig being aware of a hard floor beneath the straw.

Conclusion

These results demonstrate that deep straw will allow many bursae to resolve naturally. Overall the prevalence was reduced by almost 52% while the severity was reduced by nearly 28%.

Study 4

A comparison of Bursitis in high-welfare systems and intensive systems in the same environment.

Introduction

A behavioural study on an Institute farm, enabled a comparison of the effect of different floors on the prevalence and severity of bursitis to be made in the same environment and using the same nutrition. It also enabled a comparison between two high-welfare systems and two intensive systems with hard floors to be evaluated.

Materials and Methods

Five pens were built within a multipurpose building and all were of the same size as the Straw-Flow pen described in Figure 6.1. The pen floor systems were as follows:

Pen 1: Straw-Flow pen with a step down to dung passage

Pen 2:	Solid concrete floor with slope (1:16) and step down to dung passage
Pen 3	Fully-slatted concrete floor (Slats 10 cm wide with a 2 cm gap)
Pen 4:	Deep straw bed on sloped floor with step down to dung passage (see Plate 6.3)
Pen 5:	Straw-Flow pen with no step down to dung passage

Pens 1, 4 and 5 were identified as high welfare systems. Weaner pigs were purchased from a farm where they had been reared intensively on hard floors to around 34 kg and 17 pigs were housed in each of pens 1-4 while 15 pigs were placed in pen 5 and all were fed the same meal *ad libitum*.

The bursae were scored in the usual way and the pigs were examined on five occasions between purchase and slaughter. The rate of improvement or deterioration in bursitis was noted. The pigs were examined for foot-rot lesions of the hind feet at the slaughterhouse. The number of white line lesions, false sand cracks and erosions of the soles were noted (see Chapter 7).

Results

During the trial some pigs had to be withdrawn because of illness and one died (PSS) leaving 15 pigs in pen 1, 15 pigs in pen 2, 14 pigs in pen 3, 15 pigs in pen 4 and 15 pigs in pen 5. The date of examination, ear number, pen number and bursitis score of left and right side, at examinations 1 to 5 is noted in Appendix 6.2. The mean bursitis score, the mean prevalence of bursitis and mean weight of the pigs in each pen at examinations 1 and 5 are shown in Table 6.19. The total number of foot lesions noted in all the pigs in each pen is shown in Table 6.20.

Thus the prevalence and severity of bursitis increased in all pens apart from pen 4, the deep-strawed pen (see Figure 6.5). Although the pigs in pen 3, the fully-slatted pen, began the trial with the lowest prevalence of bursitis (57.14%), they finished with the highest prevalence (100%) and the largest increase in bursitis.

Table 6.19: The mean bursitis score, the prevalence of bursitis and mean weight of the pigs in pens 1-5.

Examination No.	Pen No.	Day No.	Mean bursitis score	Prevalence of bursitis %	Mean weight kg
1.	1	1	0.833	64.57	28.3
	2	1	0.933	66.67	27.6
	3	1	0.536	57.14	28.30
	4	1	0.933	73.3	29.70
	5	1	1.00	73.3	29.10
5.	1	70	1.300	93.33	99.8
	2	70	1.433	93.33	95.9
	3	70	1.750	100.00	95.0
	4	70	0.333	40.00	101.3
	5	70	1.433	86.67	98.9

Discussion

Pearce (1992) compared the time spent actively, in deep-strawed pens, Straw-Flow pens and completely slatted-floor pens and it was noted that the time spent active was 55%, 54% and 34% respectively, indicating that the pigs in the slatted floor pens spent more time lying. Again these findings show that concrete slats are likely to induce severe bursitis, while deep straw has a large beneficial effect. Bursitis continued to develop in both Straw-Flow pens and it was interesting to note that the increase in prevalence and severity was similar to that in the solid concrete pen.

Straw-Flow pen 1 had a step-down (100 mm) into the dung channel which made it different from the other Straw-Flow pen (5). However, there was no difference in the increase in mean bursitis score between these two pens. On the other hand, 4 out of 5 pigs, which started the trial in pen 1 without bursitis, developed bursitis during their stay in the pen, while 2 out of 4 pigs which started the trial without bursitis in pen 5 developed bursitis during their stay in the pen. It is possible that the step-down may have played a role, but no definite conclusions could be reached on these data. The number of pigs which developed bursitis, recovered from bursitis or remained unchanged throughout the trial, is shown in Table 6.21.

Fig 6.4 The mean bursitis score and prevalence of bursitis at the start and end of each trial

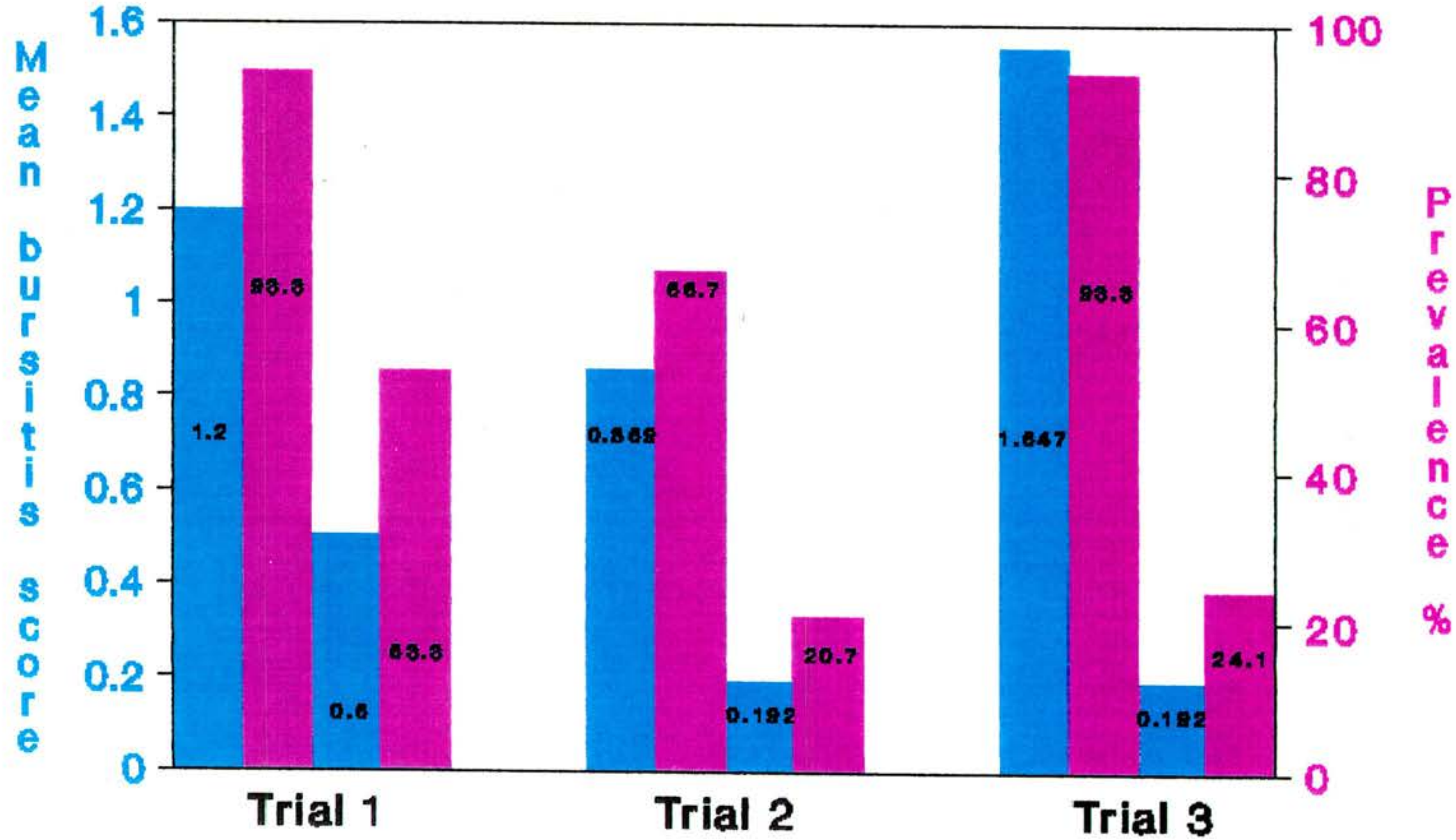


Fig 6.5 The prevalence of bursitis and mean score at successive examinations on deep straw

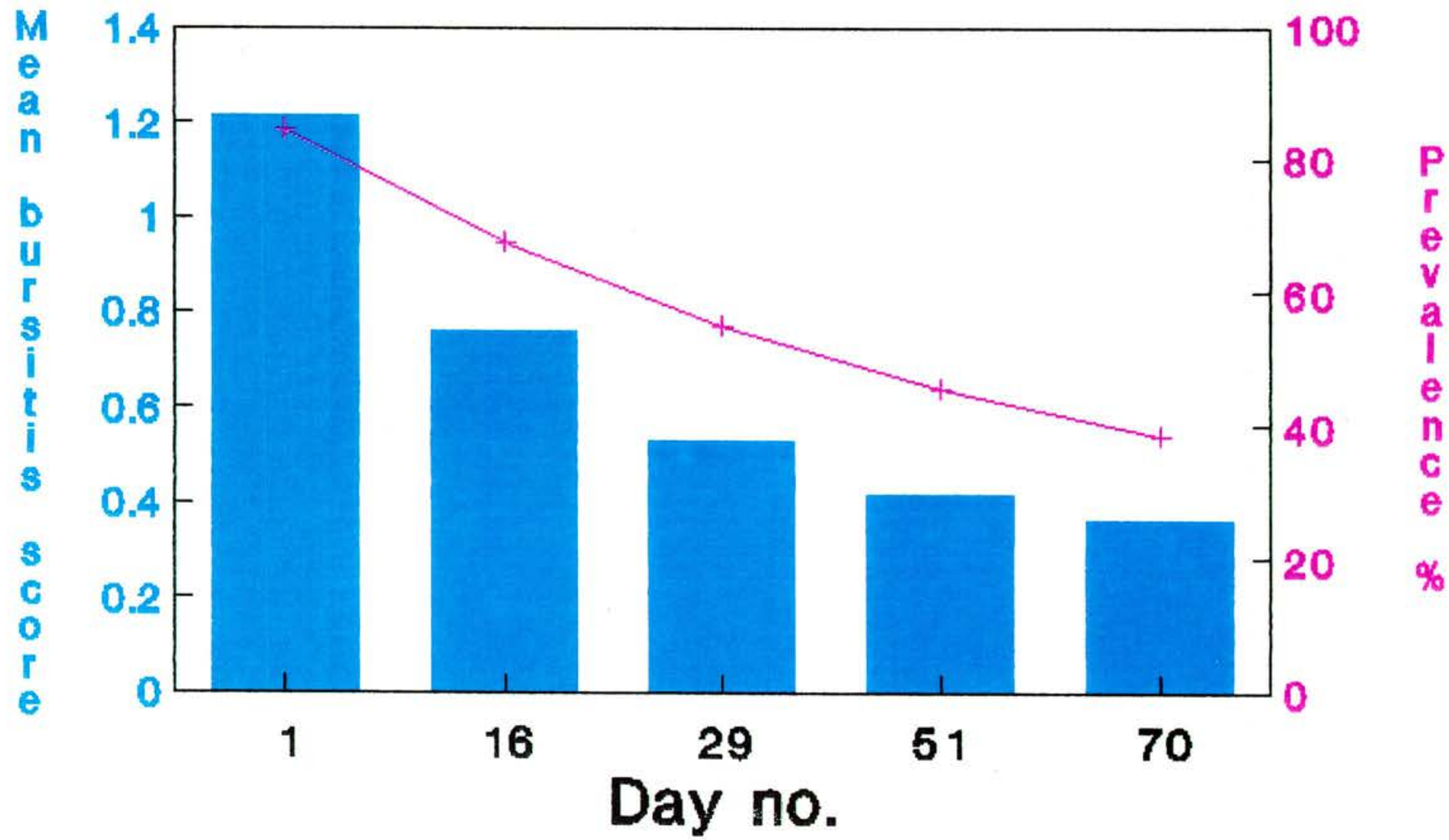


Table 6.20: The number of pigs, total number of foot lesions and the mean number of lesions per pig in pens 1-5

Pen No.	No. of pigs	Total No. lesions	Mean No. lesions per pig
1	15	45	3.000
2	15	63	4.200
3	14	48	3.429
4	15	11	0.733
5	15	35	2.333

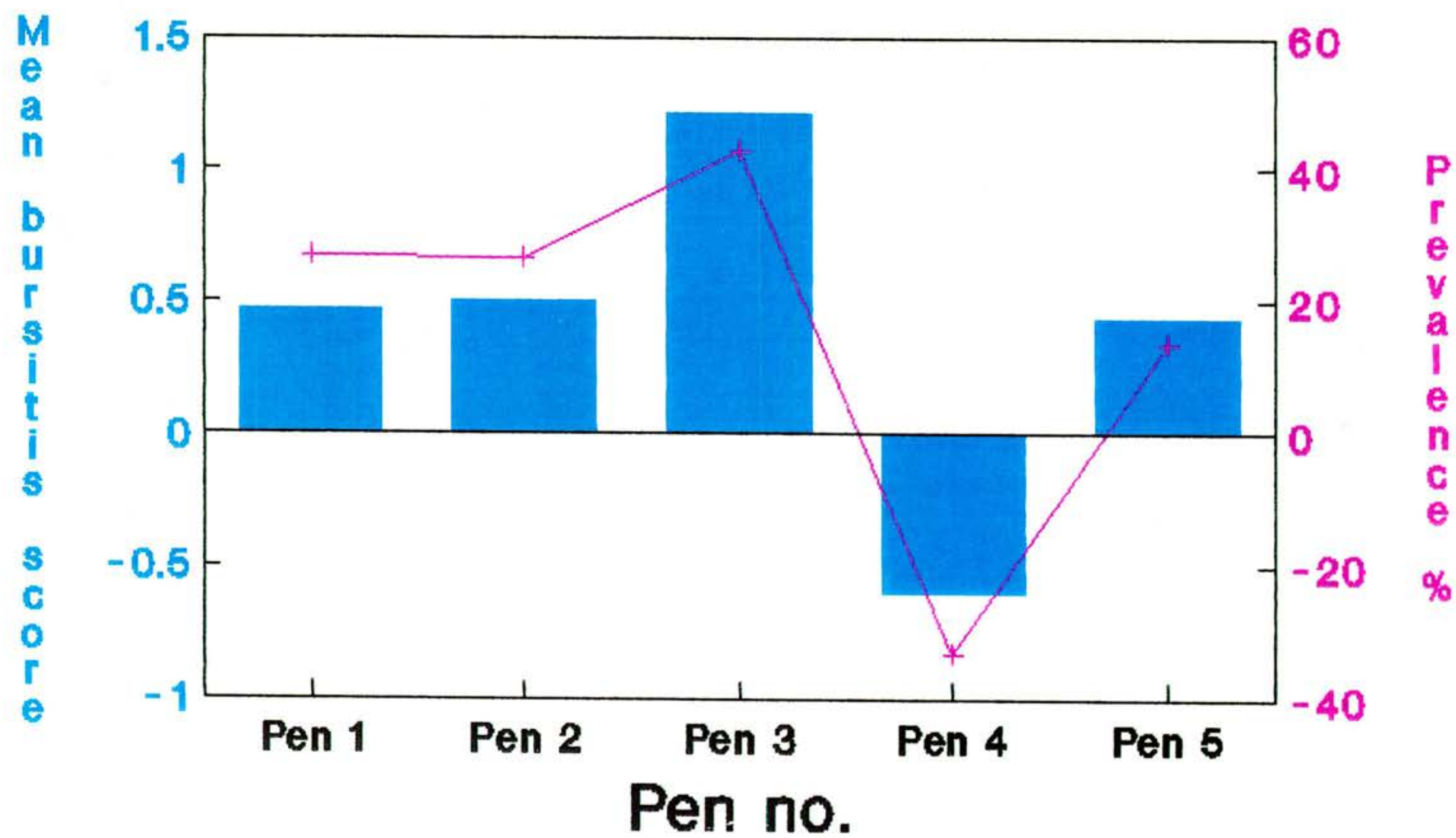
Table 6.21: The number of pigs which developed and recovered from bursitis in each pen.

Pens	1	2	3	4	5
			No. of pigs		
Category A	1	1	0	4	2
Category B	4	4	6	0	2
Category C	10	9	8	6	11
Category D	0	1	0	5	0

A = pigs free of bursitis during the trial
B = pigs which developed bursitis during the trial
C = pigs which had bursitis throughout the trial
D = pigs which recovered from bursitis during the trial

Thus, the deep straw pen (4) was the only pen in which some pigs did not start to develop bursae (see Figure 6.6). It was interesting to note that one pig in pen 2 (solid concrete floor) actually recovered from bursitis. This pig started the trial with bilateral bursae (score 1) on the medial aspect and this is an uncommon finding in itself.

Fig 6.6 The difference in the severity and prevalence of bursitis between pens 1 and 5



The number of foot-rot lesions in the pigs from pen 4 (deep straw) was significantly lower than in pigs from the other pens ($P<0.01$). However, it could be argued that foot-rot lesions might have been less prevalent in this group of pigs at the beginning of the trial. All pigs had been reared in the same type of accommodation on the farm from which they came, before the trial started. They had been weaned into flatdecks with expanded metal floors, then moved to pens with a solid concrete lying area and a concrete, slatted dunging area. As they were randomly allocated to each pen for the behavioural study, it is unlikely that foot-rot scores would have been markedly different between pens. This supposition is supported by the fact that the pigs in each pen had a significant degree of bursitis at the beginning of the trial and studies reported in Chapter 7 indicate a positive correlation between bursitis and foot-rot scores. It is therefore highly likely that deep straw has a healing effect on foot-rot lesions.

Overall Conclusion (Studies 1-4)

The floor is the main determinant in the development of bursitis. Although the Straw-Flow system has been described as a high-welfare system, the straw is not deep enough to help pigs recover from bursitis or to prevent bursitis developing in some pigs. Concrete slats are likely to induce bursitis in most of the pigs, while deep straw, and the sawdust enzyme-bedding-systems, have a markedly beneficial effect on bursitis. As the floor may also damage the claws it was decided to examine the relationship between claw lesions and bursitis. This study is described in Chapter 7.

Chapter 7

THE RELATIONSHIP OF BURSITIS TO FOOT-ROT

Introduction

A number of workers have noted that pigs with bursitis of the hock are also likely to be suffering from other conditions of the integument, especially the feet and legs (Glawischnig 1965, Backstrom and Henricson 1966, Groch *et al* 1986, Doman 1966, Penny and Hill 1974 and Berner *et al* 1990).

Earlier studies (Chapters 4 and 5) have already confirmed a positive relationship between the severity and prevalence of bursitis and the floor, especially floor hardness. Penny *et al* (1965) noted that rough concrete was a significant cause of foot-rot. A proper examination of the foot of the live finishing pig is stressful to both man and animal; indeed many pigs subjected to physical handling may become so stressed that they may die (Penny and Guise, 1990). (see Plates 7.1 and 7.2).

It may also prove difficult, or sometimes impossible, to examine the feet of pigs at the abattoir because of the type of slaughter system installed. In Scotland, two large abattoirs specialised in the slaughter of pigs only. In one of these, only the hind feet of pigs could be inspected with relative ease before pigs entered the depilation machine, while in the other, it was impossible to carry out this task. However, it is possible and relatively easy to inspect carcases for bursitis at all abattoirs. Should there prove to be a good relationship between the severity of bursitis and foot-rot in finishing pigs, then examination of the hocks at slaughter might prove an easy indirect method of assessing the suitability of floors for the raising of pigs.

Objective

1) To determine the relationship between the severity of bursitis and foot-rot in pigs.
2) To determine the number of claw lesions on both hind feet of the pigs from 10 farms with high bursitis scores.

Materials and Methods

The study was carried out in one abattoir in which the system allowed sufficient time for examining the feet and recording the lesions on emergence from the scalding tank. However, the system did not allow for the individual assessment of bursitis in each pig at the same time as its feet were being examined.

The hocks were scored for bursitis on a group basis at another point on the line. Slap marks were noted and a data file was compiled as the total number of pigs recorded from each farm increased at subsequent abattoir visits.

The five common foot-rot lesions described by Penny *et al* (1963) were noted: namely, false sand-crack, white-line lesion, heel erosion, sole erosion and toe erosion. These lesions have been reproduced in colour. (Smith *et al,* 1990).(see Plates 7.3 and 7.4) The foot lesions were recorded in the manner shown in Figure 7.1. The foot score per farm was computed by dividing the total number of foot-rot lesions by the total number of pigs per farm. This resulted in the pigs from each farm having a mean bursitis score and a mean foot-rot score. The housing was examined in those cases where the foot-rot lesions were higher than expected.

Pigs from 23 farms were included in the study and 1050 pigs in total were examined in the manner described.

Statistical Analysis

The data were analysed by regression analysis and estimates of regression coefficients were computed. See Appendix 7.1.

Results

The number of individual foot lesions and the mean bursitis score for each farm are noted in Appendix 7.2. (Note. Toe, sole and heel erosions have been combined in this instance). These data have been summarised in Table 7.1 and the mean bursitis score and mean foot score per farm are noted in Table 7.2. The farms have been placed in order of decreasing bursitis score. These data have also been presented in Figure 7.2.

Farms J and M both belonged to the same owner and not only had exactly the same housing design but also the same feeding regime. The pen floors for both rearing and finishing pigs were 3/4 solid concrete, 1/4 concrete slats and the pigs were fed a whey/meal mixture in troughs. Examination of the floors, showed that, in every case, the cement screed had been severely eroded leaving an extremely sharp abrasive aggregate exposed (see Plate 7.5).

The third farm (W), with a relatively low bursitis score and unexpectedly high foot-rot score, was one in which the pigs were reared in straw-bedded pens and then housed for the final two weeks of life on concrete slats which were badly worn.

On farm D, the pigs were housed on deep strawed concrete for 4 weeks before finishing on concrete slats (2-3 weeks). The slats were 10 cm wide with a round pencil-edge. The slat concrete was smooth and non-abrasive. The concrete in the weaners/growers accommodation was also of a smooth and relatively non-abrasive texture and no bedding was used except for sawdust in the farrowing pens.

The total number of claw lesions on either foot of pigs from the 10 farms with the highest bursitis scores is shown in Table 7.3

Plate 7.1: A pig in the early stage of the porcine stress syndrome

Plate 7.2: The same pig as above, on the point of collapse and just before death

Table 7.1: The overall distribution of erosions, white-line lesions and false sand-cracks in the hind feet. (n = 1050)

	Left Foot		Right Foot	
	Medial claw	**Lateral claw**	**Medial claw**	**Lateral claw**
Erosions	116	242	106	254
White-line lesions	178	284	197	305
False sand-cracks	121	216	129	277
Total	**415**	**742**	**432**	**836**

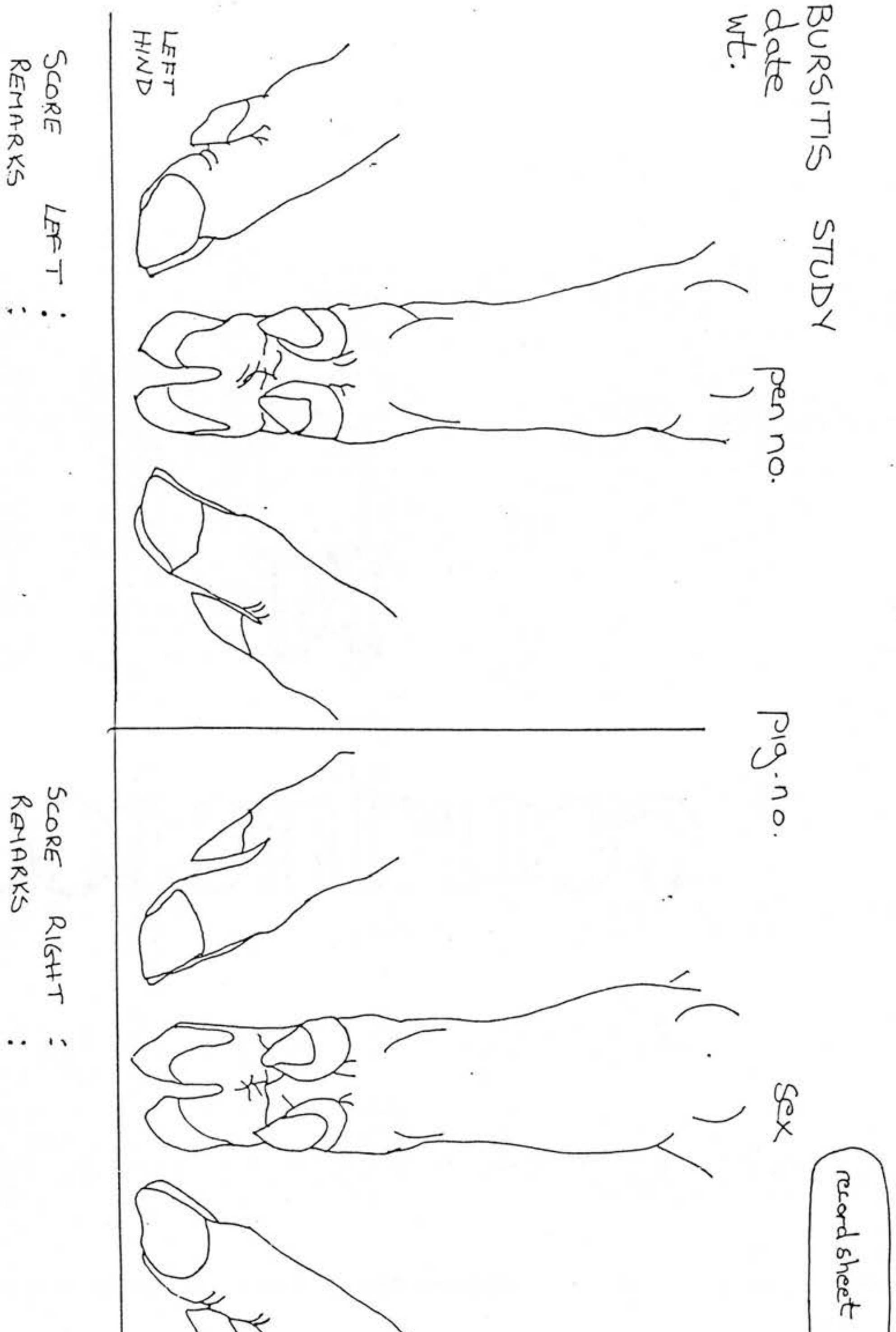
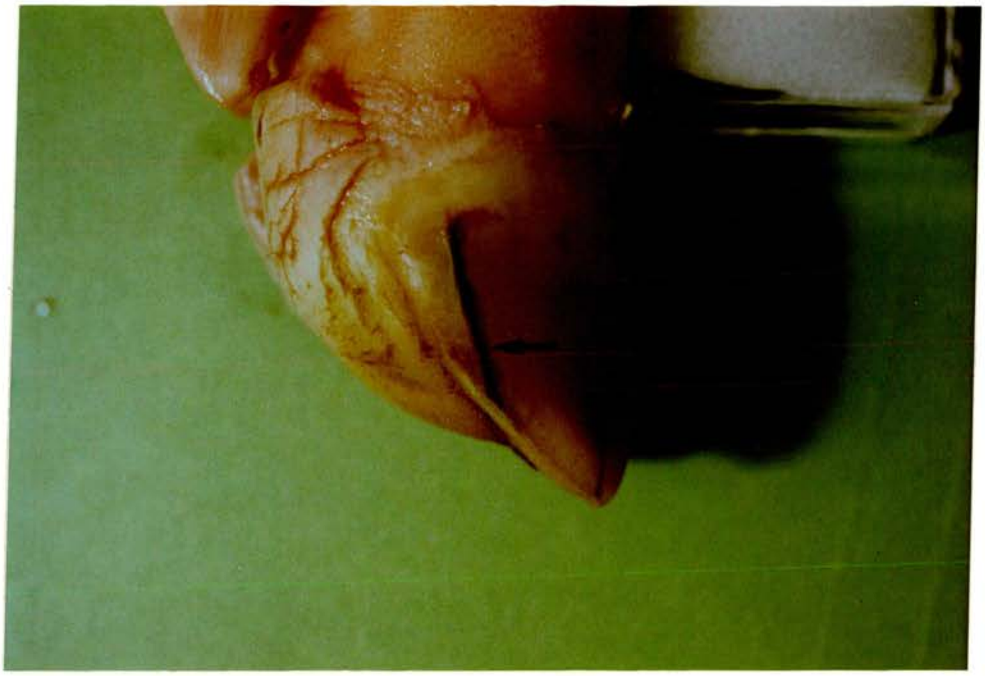


Figure 7.1: Foot lesion score record sheet

Table 7.2: The mean bursitis score per farm and the mean foot-rot score per farm in 23 farms

Farm	No. of pigs per farm	Mean Bursitis Score per Farm	Mean Foot-rot Score per Farm
A	31	2.862	4.68
B	48	2.164	4.31
C	106	2.044	2.16
D	50	2.023	1.56
E	68	2.000	3.91
F	31	1.847	2.42
G	43	1.825	3.44
H	57	1.792	3.05
I	34	1.599	2.32
J	24	1.595	4.71
K	48	1.500	1.85
L	74	1.449	2.74
M	27	1.390	4.04
N	30	1.203	2.56
O	51	1.200	2.73
P	35	0.905	1.83
Q	32	0.902	0.28
R	58	0.782	1.52
S	36	0.588	0.50
T	46	0.440	1.02
U	36	0.377	0.11
V	44	0.376	0.20
W	43	0.190	1.44



Plates 7.3: Note the false sand-crack (arrow).

Plate 7.4: Note the bilateral toe erosions (arrows)

There was a significant positive correlation between mean foot score and mean bursitis score ($p < 0.001$). The average number of foot injuries could be assessed from the following equation:

$$FI = 0.218 + 1.55\,bs$$

where FI = mean foot score

and bs = mean bursitis score

Discussion

It is interesting to note that the mean foot scores for farms J, M and W are much higher than one would expect, taking into account the relationship between foot-rot and bursitis, and this is more obvious in Figure 7.2. It has been established by other workers that whey or milk products can have a serious effect on concrete surfaces. (Osborne and Ensor, 1955, Penny *et al,* 1965 and Penny, 1967)

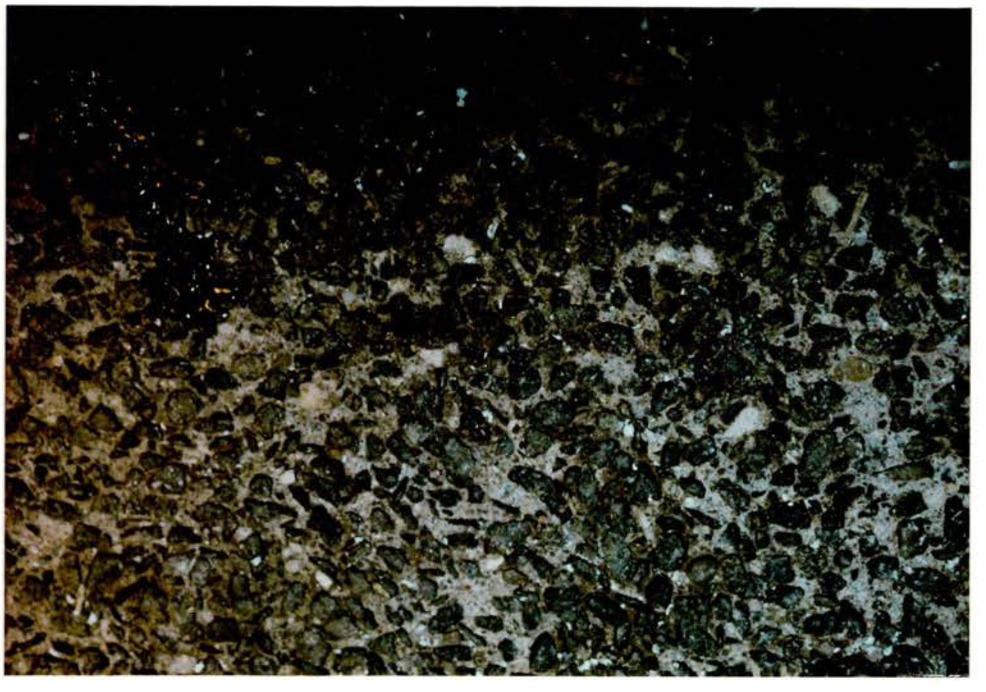
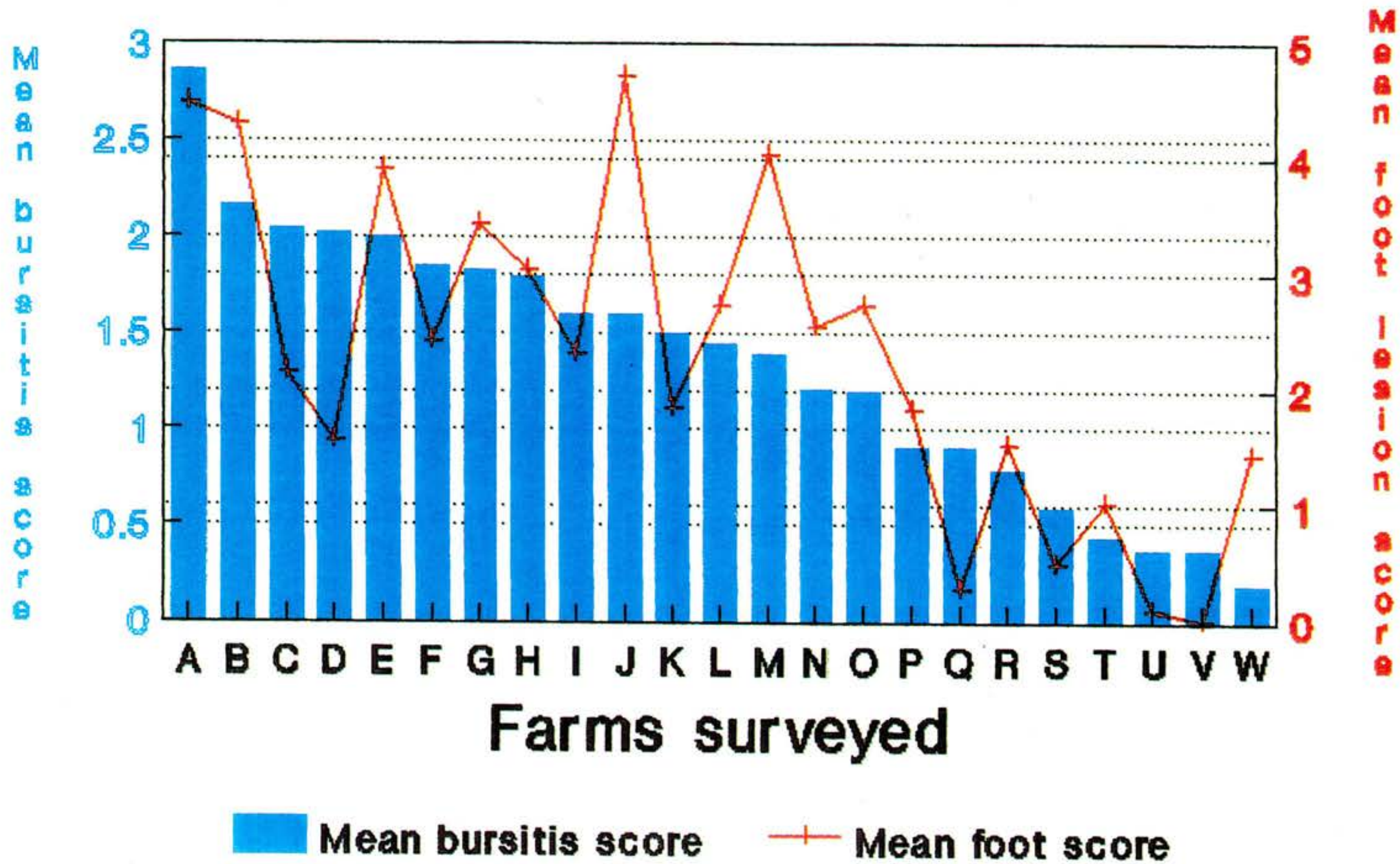


Plate 7.5: Note the erosion of the screed leaving a sharp abrasive surface

Fig 7.2 **The mean bursitis & foot score per farm, from 23 farms**



Fritschen (1973) noted that when pigs were reared on dirt lots and then finished on concrete slats the prevalence and severity of foot lesions was much higher than for contemporaries reared on concrete for the whole of their lives. It was suggested that pigs coming off soft ground, as in dirt lots, had claws of relatively soft horn which made them more susceptible to injury.

On the other hand, the pigs on Farm D, had lower foot lesion scores than would have been expected from the bursitis scores. In the case of this unit, one would not expect the prevalence of foot lesions (due to an abrasive surface texture) to be high, while the ameliorative effect of straw on bursitis would be negated to a great extent by finishing the pigs on concrete slats.

Webb (1983), using data from experiments conducted with a force-plate and pressure platform, combined with prediction equations, showed that heavier pigs would be more susceptible to foot damage than lighter pigs on the same slatted floor. The same author showed that contact pressure on a foot rose rapidly and progressively as the foot moved over the edge of a slat. The principles of bio-dynamics implicit in this finding would also apply to the skin overlying a bony prominence.

A dietary supplementation of biotin produced a significant increase in the compressive strength of pig hoof tissue (Webb et al, 1984) and it was predicted by Webb (1983) that this would have a significant protective effect for the claws of heavier pigs by allowing them to tolerate a higher floor void ratio. Webb and Clark (1981) concluded that it was important to know the point along stress-strain-time-curves at which injuries occurred.

In 1976, Lasson and Boxberger (using modelling techniques) studied permissible stress levels on the carpal joint of a cow. They reasoned that the best floor was one which allowed maximum surface area of limb to contact the floor, as this would minimise pressure over a specific area. Thus it could be argued that floors with bedding (i.e. softer floors) would minimise the pressure over bony prominences as the load would be spread more widely.

The mechanical properties of keratin are sensitive to moisture content (Fraser and MacRae, 1980, Bendit, 1975), When whey is fed, concrete floors are usually wet and this factor would have contributed to the serious claw damage noted in farms J and M.

Weaver (1978) stated that the most commonly encountered condition in cattle on slats was precarpal bursitis. Since most of the weight is borne by the forelimbs (Weaver, 1978) it would explain why carpal bursitis was more common than tarsal bursitis assuming that the condition is brought about by pressure due to weight.

It was also interesting to note that the number of claw lesions was higher in the lateral claws compared with the medial claws and this has been substantiated by other workers. (Penny et al, 1963)

Table 7.3: The total number of claw lesions on the medial or lateral claws of the left or right feet of pigs from farms A-J.

		Medial Claw	Lateral Claw
Total lesions	Left foot	245	474
Total lesions	Right foot	282	519
Total		527	993

As the lateral claw is nearly always larger (Penny et al, 1963) than the medial claw it is likely to carry more weight (Webb, 1983) and hence receive more injuries. The claw shown in Plate 7.6 depicts the large discrepancy in size, frequently noted between the lateral and medial claws.

Conclusion

The findings of this study would suggest that hard floors play a role in the development of both foot-rot and bursitis (especially concrete slats) while hard abrasive floors will have an even greater effect on the severity of foot-rot. On the whole, examination of pig hocks on the slaughter line, in the manner described, is a reasonable method of assessing the suitability of floors for rearing pigs especially with regard to their feet. In the few cases where the correlation between foot-rot scores and bursitis scores was not good, there were usually simple explanations.

It would appear that claw dimensions are highly heritable. Heritability might also play a role in bursitis and this aspect is examined and described in Chapter 8.

Plate 7.6: Note the length of the lateral claw (arrow).

Chapter 8

THE RELATIONSHIP OF BURSITIS TO HERITABILITY AND BREED

Introduction

It has been noted in several studies that the prevalence of bursitis is higher in some genotypes.

Penny and Hill (1974) noted that white breeds (prick-eared and flop-eared) were more frequently affected than coloured breeds when examined at slaughter. It was not known however if these genotypes were reared in comparable conditions and only 363 saddleback x pigs were examined in the study. Orsi (1967) came to a similar conclusion, but again the number of animals in the coloured group was small (110). Behrens and Trautwein (1964) observed bursitis in modern imported genetically improved Landrace but never in the unimproved indigenous Landrace stock.

Backstrom and Henricson (1966) made a more detailed study of the genetic effect and came to the conclusion that the offspring of Yorkshire (Large-white type) boars were more susceptible to the disorder and estimated that the mean heritability in four herds was 0.56.

These authors noted that when a boar was affected with bursitis, the offspring of that boar had significantly more bursitis than the offspring of normal boars in the same herd. However, the housing in which the boars were reared was not described.

The method of analysis used by these workers would also have given inflated heritability estimates due to common environmental effects (Bampton, 1991).

Skarman (1963) and Backstrom and Henricson (1966) both noted that the prevalence of bursitis was higher in the Yorkshire breed than in Landrace, when reared on the same farm. Variation in bursal size, without natural discontinuity, is called continuous variation. Characters exhibiting such variation are called quantitative characters or metric characters because their study depends on measurement instead of on counting. The genetic principles underlying the inheritance of metric characters are basically those of population genetics. The heritability of metric characters expresses the proportion of total variance that is attributable to the average effects of genes (Falconer, 1981). The degree of correspondence between a phenotypic value (e.g. a bursitis score) and an animal's breeding value, can be measured by the heritability which is defined as the ratio of additive genetic variance to phenotypic variance.

Study 1

The heritability of adventitious bursitis

Objective

To study the effect of heritability on the severity of bursitis.

Materials and Methods

Data on the prevalence and severity of bursitis were collected at the abattoir from pigs raised intensively in a herd used for experimental husbandry purposes. The ear tattoo numbers enabled the dam and sire to be identified. As expected, not all the piglets in each litter survived to slaughter, while others were used for particular experiments and, in a few cases simply got "lost" on the farm. A number of ear tattoos were also illegible at slaughter.

Statistical Analysis

Bursitis score on the right or left side was analysed as two separate traits. A model was fitted using sire, dam within sire, sex of pig and month of slaughter. Heritability of bursitis score was estimated by paternal half sib analysis. The estimation of heritability by sib analysis was carried out by the following procedures. Sires and dams were randomly mated to produce a population of pigs on which the data to be analysed were collected. The individuals measured formed a population of half sib and full sib families. An analysis of variance was then made by which the phenotypic variance was divided into observational components attributable to differences between the progeny of different males (between sire component), to differences between the progeny of females mated to the same male (between-dam, within-sires, component) and to differences between individual offspring of the same female (within-progenies component). The analysis was carried out on computer.

Results

Data were collected from 444 male pigs and 541 female pigs at slaughter. These were sired by a total of 11 boars. The slaughter date, tattoo number of each pig, sex, bursitis score (left and right), sow number, date, number of pigs per litter and boar number are noted in Appendix 8.1.

The severity of bursitis and the number of male and female pigs in each scoring category are shown in Table 8.1

Table 8.1 The number (%) of male and female pigs in each scoring category

Bursitis	Male		Female		All	
Score	No.	(%)	No.	(%)	No.	(%)
			RIGHT SIDE			
0	19	(4)	25	(4)	44	(4)
1	138	(31)	149	(28)	287	(29)
2	200	(45)	288	(53)	488	(50)
3	82	(19)	76	(14)	158	(16)
4	5	(1)	3	(1)	8	(1)
			LEFT SIDE			
0	27	(6)	25	(5)	52	(5)
1	120	(27)	147	(27)	267	(27)
2	200	(45)	270	(50)	470	(48)
3	93	(21)	94	(17)	187	(19)
4	4	(1)	5	(1)	9	(1)
Total	444		541		985	

The results of analysis of variance are shown in Table 8.2

Table 8.2 The results of analysis of variance

Source	DF	MS
	RIGHT SIDE	
Sire	10	4.962
Dam/Sire	211	0.992
Sex	1	0.320
Month	6	0.483
Remainder	756	0.456
	LEFT SIDE	
Sire	10	4.565
Dam/Sire	211	1.194
Sex	1	0.292
Month	6	0.599
Remainder	756	0.482

DF = Degrees of Freedom

MS = Mean Squares

Although the mean bursitis score of males (1.765) was higher than that for females (1.725) there was no significant difference and neither was there an effect of month of slaughter.

The number of progeny per sire and the least squares mean (bursitis score) for either leg are noted in Table 8.3

Table 8.3: The number of progeny per sire and the least squares mean (bursitis score) for either leg.

Sire	Number progeny	Least squares mean (Bursitis score) Right	Left
337	51	1.54	1.61
370	29	1.74	1.82
375	31	1.82	1.63
631	108	1.57	1.63
716	114	1.54	1.58
741	97	1.39	1.37
752	41	1.70	1.58
785	134	2.00	1.97
835	121	1.97	1.97
839	138	1.94	1.92
845	121	2.04	2.03

The heritability of bursitis was estimated as:

Bursitis Score Right	0.29	±	0.15
Bursitis Score Left	0.21	±	0.12
Mean	0.25		

Discussion

Every disease or disorder has a genetic component which may be significant in some cases or very small in others. If breeding pigs were reared in the same accommodation and therefore exposed to the same environmental determinants to the same degree, the prevalence and severity of bursitis in the slaughter generation could be reduced by selecting against these parents with high bursitis scores. Bäckström and Henricson (1966) investigated the heritability of bursitis in three herds and reported a mean value of 0.36.

These workers concluded that considerable importance should be attached to hereditory predisposition. The degree of heritability has not been examined by other workers.

Conclusion

Bursitis of the hock is moderately heritable, i.e. 25 % of the variation in severity is genetic in origin.

Study 2

The relationship between "breed" and bursitis

Objective

To study the effect of "breed" on bursitis.

Materials and Methods

Data regarding the prevalence and severity of bursitis in "coloured pigs" were collected at the abattoir. These were either pure bred Chinese pigs (see Plate 8.1) of the Meishan breed or crossbred pigs derived from mating a Duroc boar with a Landrace cross Hampshire female (see Plate 8.2). The Chinese pigs were raised in intensive accommodation (concrete slatted floors) in which white pigs (Landrace x Large White) were also reared and in some instances the Duroc crosses were housed in a similar fashion

Results

Chinese Pigs

Bursitis was scored in the usual manner at the abattoir where the Chinese and white pigs arrived in a mixed batch. The number of pigs of each type and the mean bursitis score for each leg in each batch of pigs are shown in Table 8.4.

Table 8.4: The mean bursitis score (L+R) and the number of chinese pigs or white pigs in each batch.

Batch No.	No. of Chinese Pigs	Mean Bursitis Score L	R	No. of White Pigs	Mean Bursitis Score L	R
2	10	0.02	0.01	67	1.62	1.62
3	9	0.00	0.00	66	1.73	1.91
4	1	0.00	0.00	60	1.63	1.67
5	10	0.01	0.01	66	1.63	1.93
Total	40	0.04	0.02	295	8.64	9.02
Mean Score		0.008	0.004		1.73	1.80
Mean Score L+R		0.006			1.765	

Thus the combined mean score of the chinese pigs was 0.008 while the combined mean score for the white pigs was 1.765. There was a highly significant difference in the severity of bursitis between the two breed types.

Discussion

All these pigs had been reared on hard floors from birth to slaughter. However, it should be borne in mind that the mean slaughter weight of the Chinese pigs was 57.1 kg as opposed to 89.7 kg for the White pigs. Even so, a previous study on the farm showed that white pigs of the same weight as the Chinese pigs had a mean bursitis score of 1.54. Not only is the skin of the Chinese pig comparatively thick, but it is much looser and tends to form wrinkles or folds, which would absorb much of the pressure induced from lying on a hard floor or prevent it being distributed through a narrow zone.

Conclusion

Chinese pigs are much less susceptible to bursitis than white pigs.

Results

Coloured Pigs

Data were collected from 910 pigs from 14 farms. The bursitis score of each leg, sex and number of pigs from each farm are noted in Appendix 8.2. These data have been summarised and are shown in Table 8.5.

Plate 8.1: **A chinese sow of the Meishan breed. Note the extensive folding of the skin.**

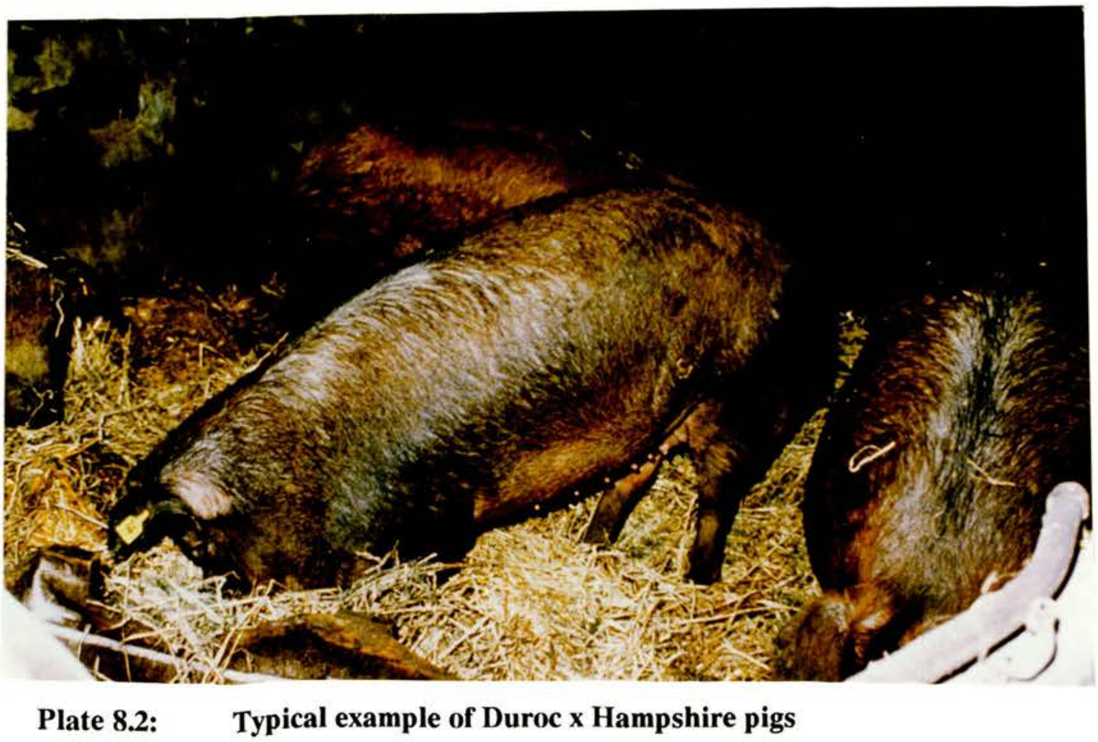


Plate 8.2: **Typical example of Duroc x Hampshire pigs**

Table 8.5: The mean bursitis score of the left and right leg and the number of pigs from each farm

Farm	No of Pigs	Mean Bursitis Score L	R
BC	113	0.0088	0.0088
DIC	41	0.3170	0.3658
GA	17	0.2352	0.1176
H22	155	0.0580	0.0387
J12	44	1.0681	0.9772
J14	31	0.9677	0.7741
J15	39	1.2820	1.2820
J22	106	0.6698	0.5943
JGD	53	0.0754	0.1132
P22	16	0.9375	0.5000
Z77	19	1.1052	1.2105
PFR	136	0.0073	0.0000
J24	133	0.5939	0.6390
C1P	7	1.4285	1.2887
Total	910	7.6006	7.9069
Mean Score		0.5429	0.5648
Mean Score L+R		0.5538	

Thus the mean bursitis score (0.554) of 910 coloured pigs was considerably less than the mean bursitis score (1.598) of the white pigs in the abattoir survey. However, the number of pigs examined was comparatively small, and it was discovered that many of these pigs were reared in bedded pens to satisfy the criteria laid down by a large wholesale meat company for which these pigs were specifically raised. However, unknown to the officials of the meat company, the weaners were sometimes housed in flatdecks with perforated floors for varying periods of time and this explained the wide range in the severity of bursitis (0.0036-1.3571). Indeed, one farmer with a breeding herd of coloured pigs, also finished about 20,000 white pigs in several intensively run units. The coloured pigs were slapped by sex and farm in which they had been finished. Those pigs slapped J12 and J14 (female) and J15 (male) were weaned into pens with solid concrete floors, with a solid concrete scrape through dung passage for 4 weeks and then finished in pens with a solid concrete lying area and concrete slatted dung passage. Pigs slapped J22 (female) and J24 (male) were placed in strawed courts for 5 weeks and then finished in pens with a concrete floor lying area and solid concrete scrape through dung passage. The same two finishing houses were used for white pigs (333) from time to time, allowing a comparison to be made between coloured and white pigs raised in the same housing system. The number of pigs, identity tattoo, breed and bursitis score of the left and right leg are noted in Table 8.6. It was also noted that five of the coloured pigs had evidence of capped hock (one bilateral).

Table 8.6: The breed, identity, number of pigs, farm, sex and mean bursitis score of left and right leg.

Farm	Pig ID	No. of Pigs	Sex	Breed	Mean Bursitis Score L	R
A	J12	44	M	Coloured	0.977	1.068
	J14	31	F	Coloured	0.774	0.968
	J15	39	M	Coloured	1.282	1.280
				Mean	1.011	1.081
	J33	70	M	White	2.501	2.468
	J33	65	F	White	2.442	2.401
				Mean	2.471	2.434
B	J22	106	M	Coloured	0.670	0.594
	J24	133	F	Coloured	0.639	0.594
				Mean	0.654	0.594
	J33	72	M	White	2.214	2.106
	J33	62	F	White	2.142	2.091
				Mean	2.178	2.098

Discussion

The beneficial effect of straw on bursitis in "both breeds" was noticeable. The combined mean score for "both breeds" was lower in farm B (straw for 5 weeks) than in farm A (1.381 v. 1.749). However, in both farms the coloured pigs had significantly less bursitis than the white pigs and this is shown in Figure 8.1 and Table 8.7.

Table 8.7: The combined mean bursitis score for males and females in both breeds on each farm.

Farm	No. of Pigs	Breed	Mean Bursitis Score
A	114	Coloured	1.058
	135	White	2.453
B	239	Coloured	0.624
	134	White	2.138

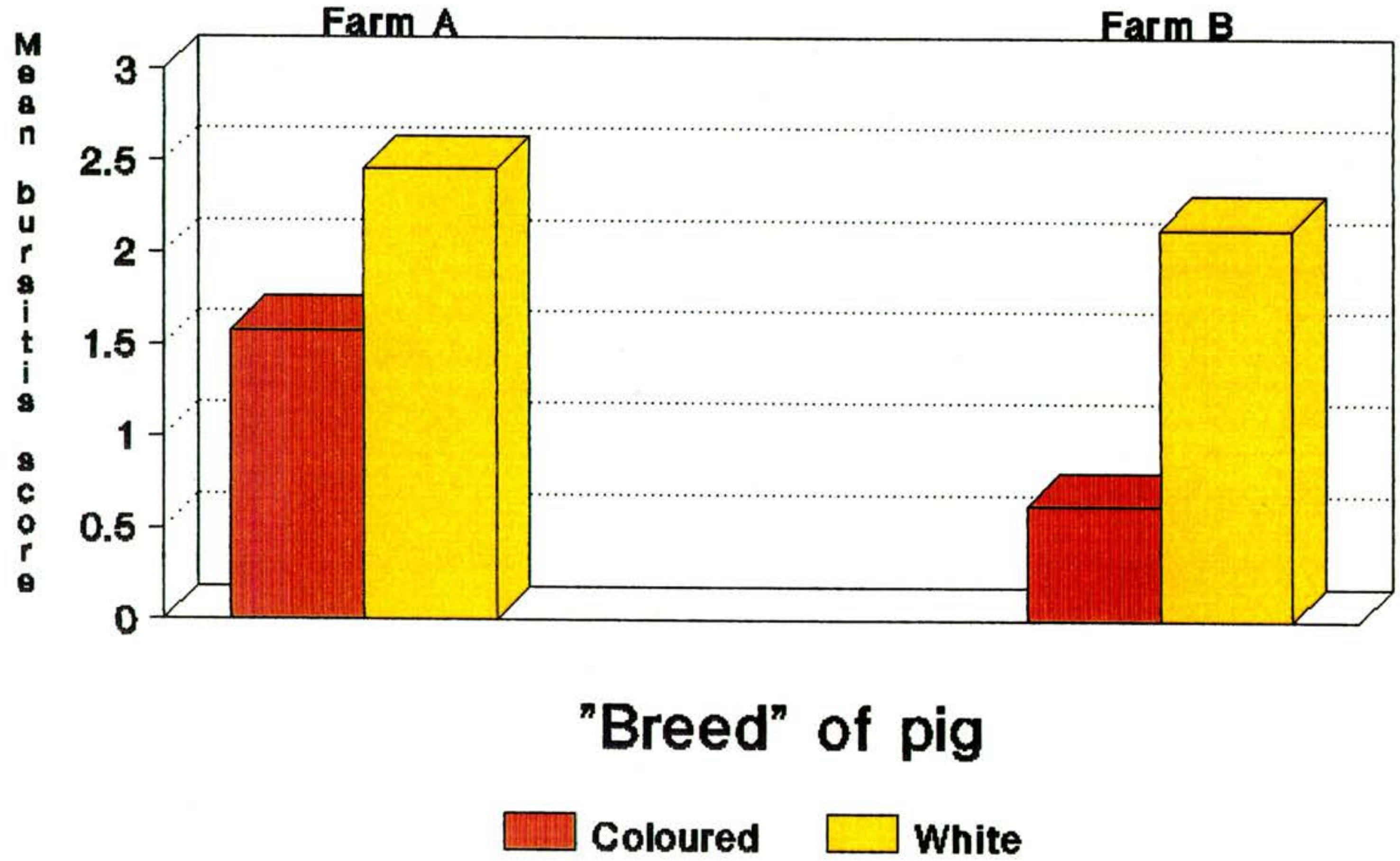
Thus, in both farms, the coloured pigs developed significantly less bursitis than white pigs housed in the same accommodation.

Conclusion

Coloured pigs had less bursitis than white pigs because they were reared in bedded accommodation in the majority of cases. However, when reared in the same intensive housing on hard floors, as white pigs, the severity of bursitis in the coloured pigs was markedly less. The provision of straw as bedding was noted to have the same beneficial effect on bursitis in coloured pigs as it had on white pigs. The findings reported in this study support those of other workers.

Although heritability and "breed" type play a significant role in bursitis, it is possible that other factors may play a role. The influence of some of these factors is described in Chapter 9.

Fig 8.1 The effect of "breed" on mean bursitis score



Chapter 9

THE RELATIONSHIP OF OTHER FACTORS TO BURSITIS

Introduction

A number of workers have mentioned other factors such as the thinner skin of Landrace-type pigs (Orsi, 1967 and Plonait, 1988), the improved imported Landrace compared with the indigenous type Landrace (Behrens and Trautwein, 1964), the long legs of the modern White pig (Watson, 1987) and the presence of other skin lesions such as tail biting, ear biting and pachyderma,(Penny et al, 1963 and Doman, 1966).

It has already been shown that there is a "breed" effect (Chapter 8) and it was thought likely that other factors may affect the prevalence and severity of bursitis.

General Objectives

To examine the role of other determinants in the development of bursitis, in particular:-

a) Subcutaneous fat
b) Skin thickness
c) Leg length
d) Skin hardness

a) The role of subcutaneous fat in bursitis

Introduction

It has already been noted that coloured pigs developed less bursitis than white pigs when reared in the same accommodation (Chapter 8). This phenomenon might be associated with the level of subcutaneous fat. It is now well established that coloured pigs (e.g. Duroc, Wessex and Hampshire) have higher mean backfat levels than white pigs as measured with an optical probe at the P2 position (level with the head of the last rib, 6½ cm from the dorsal mid-line). As adventitious bursae begin as fluid filled spaces in the subcutaneous connective tissue, it is highly probable that subcutaneous fat may act as a cushion between the skin and bony prominences.

Objectives

To determine the role of subcutaneous fat in the development of bursitis by comparing coloured pigs with white pigs.

Material and Methods

Data relating to backfat thickness for coloured and white pigs was supplied by The Meat and Livestock Commission. These were compared and statistically analysed using the Students t test.

Results

Backfat P2 measurements on 1576 white pigs and 1544 coloured pigs are summarised in Table 9.1.

Table 9.1: The number of pigs, "breed", backfat levels, range and standard deviation of each population

Breed	No. of pigs	Mean backfat level (mm)	Range (mm)	SD
White	1576	11.49	7-22	2.871
Coloured	1544	15.815	8-31	3.266

Thus, the mean backfat level of coloured pigs (15.815 mm) was higher than for white pigs (11.49 mm) and the difference was significant ($P < 0.01$ Students t test).

Discussion

One criticism which might be relevant, relates to the distribution of subcutaneous fat. It is possible that there may be little or no correlation between subcutaneous fat levels over the hock and over the back. Advice was sought from the muscle and collagen group of the University of Bristol. The answer to the question was not known but workers at the Institute did note that Piertrain pigs had slightly more subcutaneous fat in the leg at the same mean weight of subcutaneous fat in the body as white pigs (Bailey, 1991). However, although the Pietrain is a coloured pig, it is well recognised for its large muscle groups and low backfat levels. Fowler (1990), was firmly of the opinion that coloured pigs with high backfat levels would have higher subcutaneous fat levels over the hock relative to white pigs with lower backfat levels. His opinion was based on experience gained from many nutritional trials in which carcases had to be carefully dissected and examined for the distribution of fat, protein and carbohydrate.

Sabec et al (1992) studied bursitis in boars in a testing station. They noted that the severity of bursitis increased as backfat levels decreased.

Thomson (1992), after examining sections of skin from the hock area of both coloured and white pigs made the following comment: *"one interesting finding was that coloured pigs all had areas of fatty tissue in the deep dermis, whereas the white pig skin was all dense collagen and no fat. Could this fatty tissue be having a cushioning effect?"*

Conclusion

Coloured pigs have more backfat and are likely to have significantly more fat over the bones of the hock area and this may be partly responsible for coloured pigs developing less bursitis than white pigs in the same housing accommodation.

(b) The role of skin thickness in bursitis

Study 1

Introduction

It has already been noted that Chinese pigs developed less bursitis in the same accommodation as white pigs. This may have been related to their skin which is not only very thick but is also very wrinkled (see Plate 8.1). It was also noticed that coloured pigs were more susceptible to bursitis than Chinese pigs but less susceptible than white pigs (Chapter 8).

Objective

To measure skin thickness of the hock in both coloured and white pigs.

Materials and Methods

The skin thickness of both coloured and white pigs was measured *in vitro* using tissue from pigs at slaughter. A piece of skin 1 cm^2 was removed from the medial aspect of the hock above the area normally involved in bursitis and measured with Vernier callipers. Care was taken not to squeeze the callipers too tightly on the skin and the mean of three measurements was taken in each case. Values were taken from female pigs in the weight range 72-75 kg deadweight, and the coloured pigs were derived from mating a Duroc boar with a crossbred female (Hampshire x Landrace). All the pigs came from the same herd. The white pigs were of the white hybrid Large White x Landrace type. These pigs had been reared outdoors and then finished in strawed yards.

Results

The mean thickness of skin from 60 coloured pigs and 60 white pigs is noted in Table 9.2. Thus the mean skin thickness of coloured pigs (2.095 mm) was thicker than that of white pigs (1.65 mm) and the difference was highly significant ($P < 0.001$ Students t test).

Discussion

A thick skin may protect the underlying cells, capillaries and lymph ducts from the effect of pressure to some extent. Cliplef and Mackay (1989) noted that both breed and sex affected the skin thickness of pigs. When skin measurements were taken adjacent to the first thoracic vertebra, the last thoracic vertebra and the last lumbar vertebra, these workers noted that the skin of boars was thicker than that of gilts or barrows and that the skin of gilts was thicker than that of barrows. The same authors also noted that the skin of Hampshire (coloured) was thicker than that of Yorkshire carcases (white).

Conclusion

The skin of coloured pigs was thicker than the skin of white pigs (over the hock area) and this factor may explain why coloured pigs are less susceptible to bursitis.

Table 9.2: The number of pigs, mean skin thickness of coloured and white pigs, range, standard deviation and standard error.

No. of pigs	Coloured pigs 60			White pigs 60		
	Skin Thickness (mm)					
	1.7	1.8	1.7	1.5	1.9	1.9
	2.0	1.9	2.0	1.6	1.7	1.5
	1.9	1.7	2.0	1.8	1.9	1.6
	2.3	2.0	2.7	1.7	1.6	1.9
	1.9	1.7	1.9	1.9	1.6	1.7
	2.0	2.0	2.6	1.4	1.9	1.8
	1.9	1.9	2.3	1.6	1.9	1.5
	1.9	2.4	1.9	1.9	1.6	1.7
	1.9	2.0	1.9	1.7	1.5	1.6
	2.6	2.4	1.8	1.7	1.5	1.4
	2.0	1.9	1.9	1.5	1.6	1.5
	1.9	2.3	2.0	1.8	1.7	1.5
	2.4	1.9	2.1	1.6	1.5	1.6
	2.2	2.0	2.7	1.7	1.4	1.5
	1.9	2.1	2.6	1.6	1.5	1.7
	2.5	2.2	2.6	1.8	1.8	1.9
	1.9	2.0	2.0	1.6	1.5	1.5
	2.4	2.5	2.0	1.5	1.6	1.6
	2.6	1.9	2.6	1.7	1.5	1.5
	2.0	2.0	1.9	1.8	1.9	1.6
Range (mm)	1.700 - 2.700			1.400 - 1.900		
Mean	2.095			1.650		
SD	0.2831			0.1524		
SE	0.0365			0.0197		

Study 2

Introduction

As bursitis was not present in these pigs examined in Study 1, it was decided to examine the relationship between bursitis and skin thickness.

Objective

To determine the role of skin thickness in the development of bursitis by comparing data from both coloured and white pigs.

Materials and Methods

The data were collected at the abattoir. The skin "thickness" was measured by picking up a loose fold of skin in the depression on the lateral aspect of the hock with vernier callipers (see Plate 9.1). This method resulted in a double skin thickness due to the fold of skin, but is hereafter referred to as skin thickness. The same area of skin was measured on each leg while a note was made of the bursitis score and sex. The farm identity, bursitis score, skin thickness of each leg for coloured and white pigs was noted. The husbandry system used in each farm from which the pigs came, was also recorded.

Results

The farm identity, bursitis score, skin thickness of each leg for both coloured and white pigs are noted in Appendices 9.1 and 9.2 respectively.

The number of male and female coloured pigs, the mean bursitis score and mean skin thickness per farm are noted in Table 9.3.

Plate 9.1: **Measuring the skin thickness with vernier callipers**

Table 9.3: **The farm ID, number of coloured pigs, sex, mean bursitis score and mean skin thickness.**

Farm ID	Sex	No. of pigs	Mean bursitis score	Mean skin thickness value
J1	M	5	0	4.70
	F	79	0	4.82
J2	M	0	*	*
	F	71	0	4.54
J3	M	0	*	*
	F	12	0	5.55
PF	M	17	0.147	5.38
	F	22	0.090	4.05
Total		206	0.237	29.04
Mean			0.0395	4.84

Of a total of 206 coloured pigs, only 9 pigs from one farm (PF), had bursitis and their mean score was 0.0118. The mean skin thickness was 4.73 mm. It was retrospectively ascertained that the coloured pigs had spent most of their lives on deep straw bedding, apart from the pigs from farm PF which had spent the last three weeks of finishing on medium strawed concrete pens. The mean skin thickness for these animals (9) with bursitis was 4.944 mm while the mean skin thickness for those animals (30) without bursitis on the same farm PF was 4.537 mm. Thus, in this case the few animals with bursitis had thicker skins but no conclusions could be drawn because of the very small numbers involved. An analysis of regression on bursitis and thickness showed that the mean bursitis score was not related to skin thickness (see Table 9.4).

Table 9.4: Summary of regression analysis (bursitis v. thickness) for coloured pigs

	d.f.	s.s.	m.s.	v.r.
Regression	1	0.027	0.0267	0.58
Residual	37	1.704	0.0460	
Total	38	1.731	0.0455	

Estimates of regression coefficients

	Estimate	S.E.	t
Constant	0.028	0.120	0.23
Average TC	0.0189	0.0249	0.76

d.f. = degrees of freedom; s.s. = sums of squares
m.s. = means squares; v.r. = variate ratio
t. = t value

The number of male and female white pigs, the mean bursitis score per farm and the mean skin thickness per farm are noted in Table 9.5 and Appendix 9.2.

Table 9.5: The farm ID, total number of white pigs per farm, mean bursitis score and mean skin thickness in males and females

Farm ID	Sex	No. of pigs	Mean bursitis score	Mean skin thickness (mm)
NY	M	3	0.17	6.00
	F	13	0.15	4.23
LD	M	6	0.50	5.25
	F	12	0.08	4.79
DD	M	17	0.35	3.21
	F	3	0.00	3.17
IC	M	12	0.67	5.00
	F	16	0.84	4.37
7G	M	39	1.03	5.48
	F	29	1.16	5.17
7J	M	47	1.04	4.09
	F	37	1.17	4.27
9C	M	78	1.99	3.99
	F	68	1.62	3.79
CD	M	83	1.40	4.45
	F	58	1.10	4.09
DL	M	4	1.75	5.75
	F	14	1.25	4.78
GG	M	12	2.00	4.05
	F	12	1.95	4.03
OR	M	5	1.90	4.10
	F	2	3.00	6.25
Total		570		
Mean			1.123	4.328

Of the 570 white pigs from 11 farms, 431 (75.16%) had bursitis with a mean score of 1.12. The mean skin thickness for all the pigs was 4.32 mm. An analysis of variance was carried out on the data from each farm from which small numbers of pigs were examined (5 farms). In each case there was no relationship between skin thickness and the severity of bursitis. However, in this group it was noticeable that the pigs with thinner skin had a greater tendency to develop bursitis. (see Table 9.6).

Table 9.6: The farm ID, number of white pigs, mean bursitis score and mean skin thickness for these pigs with and without bursitis.

Farm ID	No. of pigs with bursitis	Mean bursitis score	Mean skin thickness (mm)	No. of pigs without bursitis	Mean skin thickness (mm)
NY	4	0.50	4.625	12	4.542
LD	5	0.80	5.000	13	4.923
DD	8	0.75	3.438	12	3.042
DL	4	1.75	4.893	14	5.375
OR	7	2.214	4.714	0	*

The same analysis was then applied to data from farms from which more than 20 pigs had been examined (6). The farm ID, the number of pigs from each farm, sex, mean bursitis score and mean skin thickness are noted in Table 9.7.

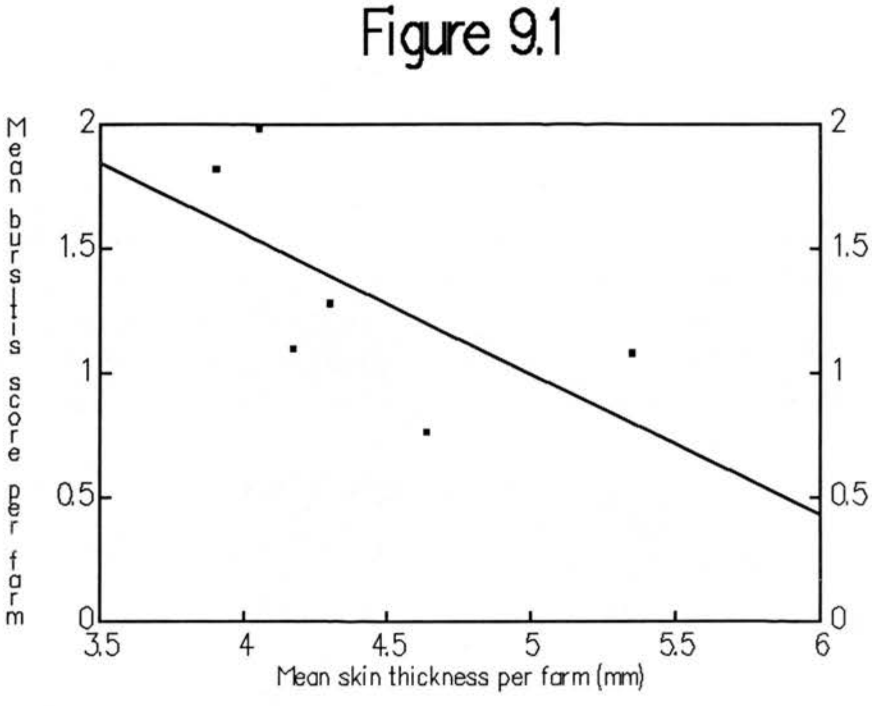
Table 9.7: The farm ID, number of white pigs, mean bursitis score and mean skin thickness per farm.

Farm ID	Sex	No. of pigs	Mean bursitis score	Mean skin thickness score (mm)
IC	M	12	0.667	5.000
	F	16	0.844	4.375
7G	M	39	1.026	5.482
	F	29	1.155	5.172
7J*	M	47	1.043	4.091
	F	37	1.176	4.273
9C*	M	78	1.199	3.999
	F	68	1.162	3.790
CD	M	83	1.404	4.452
	F	58	1.103	4.091
CG*	M	12	2.000	4.058
	F	12	1.958	4.033

* signifies significant negative slope between mean skin thickness and bursitis score.

These same data relating to mean skin thickne|s and mean bursitis score per farm are also shown in Figure 9.1.

Figure 9.1: The relationship between mean bursitis score per farm and mean skin thickness per farm for white pigs.



Discussion

Thus, there is an indication that pigs with the thicker skins are likely to have lower bursitis scores. Indeed, in three farms there was a significant negative correlation between skin thickness and bursitis score. These were the three herds with the lowest mean bursitis scores (see Appendix 9.3).

Conclusion

Skin thickness has little effect on bursitis until a threshold is reached below which the bursitis score will increase. The mean skin thickness of coloured pigs was greater than the mean skin thickness of white pigs.

(c) The role of leg length in bursitis

Introduction

Watson (1987) suggested that leg length was an important determinant in the development of bursitis. This feature has not been mentioned by other workers. It is possible that the length of leg might influence the posture of the pig at rest and hence the severity of bursitis. It was decided to investigate this possibility.

Objective

To determine the role of leg length in the development of bursitis in both coloured and white breeds.

Materials and Methods

For the purpose of the study, leg length was taken as the distance between the point of the hock and the point of the toe of the lateral claw. Although it is admitted that claw length may vary between legs, the point of the toe was found to be the most reliable place to consistently fix the lip of a measuring tape on a moving object (see Plate 9.2). The length of each leg was measured in centimetres and bursitis was scored in the usual manner for each leg. Data were collected from 210 coloured pigs from five herds and 383 white pigs from 11 herds. These data were analysed by analysis of variance and regression analysis.

Results

The data collected regarding bursitis score and leg length are presented in: Tables 9.8, 9.9, 9.10, 9.11, 9.12, 9.13 and 9.14 (see also Appendices 9.4 and 9.5).

The farm ID, sex, mean bursitis score and mean leg length of coloured pigs are noted in Table 9.8.

Plate 9.2: Measuring leg length with a circular steel tape.

Table 9.8: The farm ID, sex, number of coloured pigs, mean bursitis score and mean leg length per farm.

Farm ID	Sex	No. of pigs	Mean bursitis score	Mean leg length (cm)	No. pigs with bursitis
FP	M	26	0.000	25.02	0
	F	35	0.014	24.49	1
4J	M	0	*		*
	F	55	0.645	23.94	32
2J	M	67	0.686	24.58	37
	F	0	*		*
7Z	M	6	0.583	23.03	4
	F	14	1.392	23.96	13
IP	M	5	1.300	23.86	4
	F	2	1.500	23.75	2
Total		210			
Mean			0.5452	24.34	

From these data, it would appear that there was little or no correlation between mean bursitis score and mean leg length. The mean leg length of those pigs with bursitis was compared with those without bursitis within the same farm and the results are shown in Table 9.9.

Table 9.9: The farm ID, sex, no. of pigs with/without bursitis and mean leg length of coloured pigs per farm.

Farm ID	No. of pigs with bursitis	Mean bursitis score	Mean leg length (cm)	No. of pigs without bursitis	Mean leg length (cm)
4J	32	1.109	23.96	23	23.91
2J*	37	1.24	24.92	30	24.11
7Z	17	1.352	23.66	3	23.80
IP	6	1.583	23.80	1	24.00
Total	92		96.43	57	95.82
Mean			24.11		23.955

* signifies a significant relationship between leg length and bursitis score.

There was no relationship between leg length and bursitis score except for one farm [2J] in which the relationship was significant, i.e. as the leg length increased the bursitis score was significantly increased (see Table 9.10).

Table 9.10: Summary of regression analysis Herd 2J (bursitis v. leg length)

	Regression Analysis			
	d.f.	**s.s.**	**m.s.**	**v.r.**
Regression	1	12.63	12.6330	25.05
Residual	65	32.78	0.5044	
Total	66	45.42	0.6882	

	Estimates of Regression Coefficients		
	Estimate	**S.E.**	**t.**
Constant	-9.83	2.10	-6.67
AVLC	0.4279	0.0855	5

d.f.	=	degrees of freedom	s.s.	=	sum of squares
m.s.	=	mean squares	v.r.	=	variate ratio
S.E.	=	standard error	t.	=	t value

In the other farms there was no relationship between leg length and bursitis score both within farms and between farms.

The farm ID, number of white pigs, mean bursitis score and mean leg length per farm and sex are noted in Table 9.11 and Appendix 9.5.

Table 9.11: The farm ID, number of white pigs, sex, mean bursitis score and mean leg length per farm.

Farm ID	Sex	No. of pigs	Mean bursitis score	Mean leg length (mm)	No. with bursitis
AR	M	4	1.125	25.75	4
	F	11	0.864	26.08	11
FS	M	0	*	*	*
	F	12	1.000	22.34	10
TS	M	32	1.250	25.92	32
	F	17	1.118	26.28	17
3N	M	60	1.358	24.71	57
	F	19	0.974	24.58	15
KW	M	15	1.100	25.27	13
	F	9	1.778	25.28	9
OR	M	33	1.348	24.59	28
	F	29	1.379	23.87	27
EF	M	7	1.714	23.99	5
	F	8	1.125	23.15	7
AO	M	3	1.000	27.67	3
	F	13	1.654	26.81	13
YU	M	19	1.816	24.38	19
	F	20	1.425	23.75	18
RA	M	28	1.714	26.70	28
	F	15	1.467	26.19	15
DD	M	38	2.250	24.52	38
	F	13	2.269	24.28	13

A glance at these data would suggest that there was no relationship between leg length and bursitis. Again the mean leg length of those pigs with bursitis was compared to those pigs without bursitis within each farm (from farms with less than 20 pigs examined) and the results are noted in Table 9.12.

Table 9.12: The farm ID, number of white pigs, mean bursitis score and mean leg length

Farm ID	No. of pigs with bursitis	Mean bursitis score	Mean leg length (cm)	No. of pigs without bursitis	Mean leg length (cm)
FS	10	1.20	22.48	2	21.65
EF	13	1.615	23.47	2	24.00

Two farms AO and AR had no pigs without bursitis and had to be discarded from the analyses. There was no relationship between leg length and bursitis score in the two herds from which small numbers were examined. The data from herds from which more than 20 pigs were examined are combined in Table 9.13.

Table 9.13: The farm ID, number of white pigs, sex, mean bursitis score and mean leg length.

Farm ID	No. of pigs	Sex	Mean bursitis score	Mean leg length (cm)
TS	32	M	1.250	25.92
	17	F	1.1180	26.28
3N	60	M	1.358	24.71
	19	F	0.974	24.58
KW	15	M	1.000	25.27
	9	F	1.778	25.28
OR	33	M	1.348	24.59
	29	F	1.379	23.87
YU	19	M	1.816	24.38
	20	F	1.425	23.75
RA	28	M	1.714	26.70
	15	F	1.467	26.19
DD*	38	M	2.250	24.52
	13	F	2.269	24.28

* Indicates a significant relationship between mean leg length and mean bursitis score.

There was no relationship between leg length and bursitis apart from one farm DD in which the relationship was significant (see Table 9.14).

Table 9.14: Summary of regression analysis for farms with more than 20 white pigs examined (bursitis v. leg length).

		Regression Analysis		
	d.f.	**s.s.**	**m.s.**	**v.r.**
Regression	6	40.5	6.7583	13.35
Residual	340	172.2	0.5064	
Total	346	212.7	0.6148	
		Estimates of Regression Coefficients		
Farm ID	**Estimate**	**S.E.**	**t.**	
Constant	1.204	0.102	11.84	
3N	0.062	0.129	0.48	
KW	0.150	0.177	0.85	
OR	0.159	0.136	1.17	
YU	0.411	0.153	2.69	
RA	0.424	0.149	2.85	
DD	0.051	0.142	7.38*	

*		signifies a significant relationship between leg length and bursitis for farm DD.			
d.f.	=	degree of freedom	s.s.	=	sum of squares
m.s.	=	mean squares	v.r.	=	variate ratio
S.E.	=	standard error	t.	=	t value

Discussion

It is difficult to conceive how longer legs might in some cases cause more bursitis to develop. It is possible that animals with longer legs may have weaker legs and hence may wish to lie for longer periods. On the other hand, it is also possible that animals with longer legs might lie in such a fashion, that more weight is distributed through the hock area. Although Watson (1987) was firmly of the opinion that animals with longer legs were more likely to have bursitis, he did not present any data to support his opinion.

Conclusion

Generally, both between and within herds of coloured and white pigs, there appears to be little relationship between leg length and bursitis. However, in two farms, 2J (coloured) and DD (white) the pigs had significantly more bursitis when the hock to claw length was greater.

(d) The role of skin hardness in bursitis

Introduction

Hardness or softness is another component of skin texture which may play a role in the pathogenesis of bursitis. It is well established that boars have thicker skin over the shoulder area which feels harder to touch. This is said to protect them from wounds during fighting and skirmishing.

Objective

To establish the relationship between skin hardness and bursitis in both coloured and white pigs.

Materials and Methods

An instrument called an Exacta shore hardness tester was used for the purpose of the study. This instrument is built in accordance with BS903 Part 20, DIN53/505, ASTMD2240 and is used for accurate checking of hardness of elastic material such as plastics, cork, neoprene and natural rubber products. It consists of a rigid aluminium housing which accommodates the calibrated measuring system and the scale is divided into 0-100 shore units. Usually the instrument is placed with the penetrator at right angles to the surface of the speciment being tested, simply by laying the instrument on the surface under test. The amount of penetration is inversely proportional to the hardness of the surface being tested. The skin over the lateral aspect of each hock, but above the area normally involved in bursitis, was tested with the instrument. Three measurements were taken at each site and an attempt was made to place the instrument against the skin with the same pressure, as if it were itself, sitting on the skin (see Plate 9.3).

Therefore, the readings would only, at best, give a crude estimate of skin hardness when used in this way. The data collected were examined by an analysis of variance and regression analysis.

Plate 9.3: Measuring the skin hardness with an Exacta meter

Results

The farm identity, sex, bursitis score of left and right leg and skin hardness data (in shore units) for each leg in coloured pigs are noted in Appendix 9.6. The data were analysed by analysis of variance but no relationship between skin hardness and bursitis score was demonstrated. Of 188 coloured pigs from five farms, 53 (28.19%) had evidence of bursitis and the pigs from two farms with highest mean bursitis scores also had lowest mean skin hardness scores.

Data were collected from 889 white pigs from 24 farms and are shown in Appendix 9.7. Data relating to the four farms with the lowest mean bursitis scores and the four farms with the highest mean bursitis scores and mean skin hardness are presented in Table 9.15.

Table 9.15: The farm ID, sex, number of pigs, mean bursitis score and mean hardness (shore units) value.

Farm ID	Sex	No. of pigs	Mean bursitis score	Mean hardness value (shore units)
AH	M	45	0.089	10.47
	F	0	*	*
SD	M	24	0.188	8.46
	F	24	0.125	7.62
SF	M	3	0.667	15.83
	F	4	0.000	14.50
AR	M	7	0.500	10.79
	F	7	0.143	12.14
BS	M	4	2.000	15.25
	F	3	1.167	14.33
2A	M	23	1.696	13.98
	F	4	1.875	14.00
PS	M	8	1.813	10.88
	F	5	2.000	10.80
DD	M	19	2.421	5.68
	F	16	2.688	5.66

Bearing in mind that the hardness value is inversely related to skin hardness, it would appear that there was no relationship between skin hardness and bursitis and this was confirmed when the data were analysed by regression analysis (see Appendix 9.8). However, the pigs with the highest mean bursitis score also had the lowest mean hardness score (Farm DD).

Discussion

The mean skin hardness value for 188 coloured pigs was 6.729 while the mean value for 720 white pigs (herds with >20 pigs examined) was 10.010. This would indicate that coloured pigs have harder skins than white pigs (bearing in mind the inverse relationship in hardness value) and may help to explain why they have less bursitis in the same housing conditions as white pigs. Nevertheless, in both white and coloured herds a significant relationship between skin hardness and bursitis score was not demonstrated. It could be argued that the method of measurement was rather crude and this criticism has to be accepted. Nevertheless in both coloured and white herds, the pigs from herds with highest mean bursitis scores also had the softest skins.

Conclusion

Skin hardness of both coloured and white pigs had no effect on bursitis within farm and between farms. However, it may partly explain the difference in severity of bursitis between white and coloured pigs reared in the same accommodation.

Overall Conclusion

Of all the factors considered in this chapter, subcutaneous fat probably played the most significant role in the mitigation of the severity of bursitis. Skin thickness played a less important role while other factors such as hair thickness and skin hardness were of little or of no significance.

Chapter 10

ECONOMIC ASPECTS OF BURSITIS

Introduction

Bursitis may cost the pig industry money for two main reasons: firstly, the cost of trimming at the abattoir and secondly, the cost of lower selection rates in gilts and boars destined for sale for breeding. There may be other less well recognised minor costs related to public health and the welfare of the pig such as the cost of hospitalisation.

Study 1

An abattoir study of trimming practices and costs.

Introduction

Meat inspectors tend to use their own judgement when deciding how to deal with such matters as trimming unsightly blemishes on the carcase or removing retained hair after exit from the dehairing machine. These 'costmetic' operations are usually carried out on the moving line and the time devoted to such tasks may vary greatly between inspectors.

Objective

To determine the cost of bursal trimming.

Materials and Methods

The cost of trimming was examined at two abattoirs totally dedicated to the slaughter of pigs. The number of pigs trimmed, the leg affected, sex, mean farm bursitis score and meat inspector involved was noted in each abattoir. In each abattoir, three meat inspectors worked on the slaughter line. In abattoir A, meat inspectors worked on a rotation basis so that their duties changed on a regular basis and each person was based at a different point on the line. In abattoir B, the three meat inspectors worked as a team at one point of the line. When data collection began, the meat inspectors involved at both abattoirs soon realised that they were being observed, especially in relation to trimming and this resulted in the number of bursae being trimmed rising markedly. The initial data were therefore discarded and another approach was used. In abattoir A, observation of the trimming took place from a totally separate area, as the line ran in a "U" shape. In abattoir B, the trimming process could be observed from another point, while pretending to examine the lungs. The time taken to trim a bursa was assessed and the weight of bursal tissue trimmed was calculated. A total of 1815 pigs was observed in abattoir A, while a total of 340 pigs was observed in abattoir B. The pigs at abattoirs A and B came from 43 and 7 farms respectively.

Results

The abattoir involved, the farm identity, number of pigs from each farm and the mean bursitis score per farm are noted in Table 10.1. The number of pigs trimmed on the left leg, right leg or both legs in both abattoirs is shown in Table 10.2. (see also Appendix 10.1 and Figure 10.1) These data indicate that in both abattoirs, both legs were trimmed more frequently than either the left or right leg only. This finding would support the results of the abattoir survey which showed that bursitis was usually bilateral. However, in abattoir A there was a bias in favour of the right leg when only one leg was trimmed. The mean bursitis score for all pigs at abattoirs A and B was 1.64 and 1.61 respectively. However, in abattoir B the overall trimming rate in both legs was 10% higher than in abattoir A. Analysis of the data showed that there was no "abattoir effect" but there was a significant and positive correlation between the number trimmed and the mean bursitis score (see Appendix 10.2). The analysis also showed a large variation in the number trimmed between batches irrespective of the bursitis score, especially in abattoir A. Most bursae were detached with one slice of the knife but in approximately 1 in 14 cases two attempts were required. On average, these component times took 3.1 seconds/pig, bearing in mind that more than half the pigs had both legs trimmed. During the trimming study, 600 bursae were collected and weighed. The total weight was 7.2 kg indicating that on average one bursa would weigh 12 g. In Scotland, 798,000 pigs were killed in 1991 and if the lower trimming figure of 16% (both legs) was taken as minimal value, then approximately 255,360 bursae were trimmed from pigs in Scotland during the year. Thus, the total weight of bursae trimmed would be approximately 3064.32 kg. As the average price of pig meat in 1991 was 103 pence per kg deadweight, then the cost of trimming, due to bursitis, was probably in the region of £3,156.25. This cost relates only to the weight of tissue trimmed.

Another cost related to meat inspection, was the number of haughs (part hams) condemned because of bursae with erosions. In Chapter 2, it was noted that 125 pigs

(0.889%) of 14046 pigs had bursal erosions. However, only 40% were infected to a degree which warranted condemnation of a haugh. If this figure is applied to the total Scottish pig kill of 798,000 pigs then it is likely that 2838 haughs were condemned during the year. As the average weight of each haugh condemned was 1 kg this represented a loss of about £2923.14 during 1991. In addition to this loss, must be added the value of those pigs which had not been hospitalised in time and which had been destroyed on the farm because they had been deemed unfit to travel. However, it is likely that this figure would have been minimal and impossible to cost anyway, so it has been omitted.

Discussion

A number of interesting points arise from the analysis of the data. In abattoir A, where the meat inspectors worked separately, trimming was the last task carried out by the meat inspector. All the meat inspectors were right handed. As the pigs moved away from the bench on which the meat inspector was standing, the right side of the pig was the one most prominently displayed and easy to access. Sometimes the left side of the pig was almost out of range before the meat inspector had time to start trimming if required. So it was not surprising that there was a bias to the right side in this abattoir. Penny (1989) noted that more bursae were trimmed on the left hock even though bursitis was more prevalent on the right side. The variation in the number trimmed between batches (farms) could be explained in a number of ways.

In abattoir A, one meat inspector never trimmed bursae and this might also explain the 10% difference in total per cent trimmed between the abattoirs in spite of the mean bursitis score being similar. It was also common knowledge amongst pig farmers, that abattoir A would take all the porker pigs (65-75 kg liveweight) from a farm as well as the bacon pigs (85-90 kg liveweight). In Scotland, most farmers endeavour to produce pigs in the bacon weight range and any pigs which fail to grow or become "runty" are consigned as porkers. These are pigs which are " old" for their weight and have been lying for longer periods for reasons associated with lameness and/or illness. As many of these pigs required more of the meat inspectors' attention, e.g. because of pleurisy stripping or arthritis, there was little time to deal with trimming, which was often required, because of the bursitis induced by lying more frequently. Variation in the number trimmed between batches, might also be explained by the fact that pigs from some farms had a serious pleuropneumonia problem and many pigs required pleural stripping.

Table 10.1: The farm ID, no. of pigs per farm, no. of bursae trimmed per farm and the mean bursitis score per farm in Abattoirs A and B.

Farm identity	No. of pigs	No. bursae trimmed	Mean bursitis score per farm
Abattoir A			
A	75	0	0.588
B	13	0	0.650
C	8	1	1.000
D	24	0	1.020
E	12	0	1.043
F	18	3	1.113
G	40	2	1.180
H	81	16	1.220
I	24	8	1.267
J	11	0	1.356
K	41	3	1.362
L	13	5	1.380
M	30	5	1.543
N	34	46	1.551
O	19	1	1.570
P	46	14	1.613
Q	53	0	1.651
R	24	8	1.750
S	20	4	1.755
T	128	20	1.765
U	20	3	1.784
V	58	1	1.822
W	39	5	1.833
X	44	10	1.870
Y	50	5	1.879
Z	44	14	1.897

Table 10.1 (Contd.)

Farm identity	No. of pigs	No. bursae trimmed	Mean bursitis score per farm
Abattoir A (contd.)			
A^1	17	13	1.912
B^1	17	10	1.980
C^1	61	8	2.000
D^1	58	23	2.017
E^1	18	0	2.044
F^1	82	49	2.077
G^1	64	12	2.110
H^1	212	102	2.115
I^1	56	32	2.137
J^1	15	11	2.200
K^1	23	10	2.264
L^1	141	91	2.314
M^1	18	0	2.420
N^1	50	17	2.659
Abattoir B			
A^2	15	1	1.244
B^2	34	18	1.327
C^2	44	22	1.443
D^2	46	11	1.730
E^2	22	5	1.847
F^2	43	23	2.023
G^2	36	18	2.205
H^2	81	72	2.250

Table 10.2 The number of pigs trimmed on the left leg, right leg or both legs in Abattoirs A and B

	Abattoir A		Abattoir B	
Site trimmed	**No. of pigs (%)**	**Mean bursitis score**	**No. of pigs (%)**	**Mean bursitis score**
Left leg	71(3.91)		19 (5.59)	
Right leg	114 (6.28)		19 (5.59)	
Both legs	196 (10.80)		70 (20.59)	
Neither leg	1434 (79.01)		232 (68.23)	
Total	1815 (100.0)	1.64	340 (100.00)	1.61

In abattoir A, carcases were sometimes exported to EEC countries and this required the placement of more official stamps on the carcase, which again reduced the time available for trimming. In both abattoirs the number (%) of pigs trimmed tended to drop towards late afternoon when the men began to tire. Abattoir A also tended to accept coloured pigs, the offspring of Duroc/Hampshire parents and these carcases required more attention in relation to hair removal, a task in which the meat inspectors sometimes participated. It was also noted, that bursae on the forelegs were very rarely trimmed. This finding parallels that for arthritis which is more frequently detected in the hind limbs than the fore limbs. (Cross, 1974). It was noted that medial bursae were never trimmed. The percentage of pigs trimmed in this study varied from approximately 10%-30% depending on the abattoir.

Penny (1989) observed trimming at one abattoir and noted that the percentage of pigs trimmed varied between batches from 9.30% to 12.82% where 2.6% of the lesions were described as severe (1718 pigs). The mean bursitis score in the abattoir survey was 1.598 so the pigs examined in this study had slightly more severe bursitis (mean score 1.625). The abattoir survey showed that 87% of pigs had some degree of bursitis, so it can be concluded that bursae will only be deemed unsightly or worthy of removal when they are large, i.e. at the top end of the scoring range. This would indicate that although the meat inspectors tend to trim large bursae mainly, a considerable number of large bursae will pass untrimmed and this was confirmed by our observations at the abattoir.

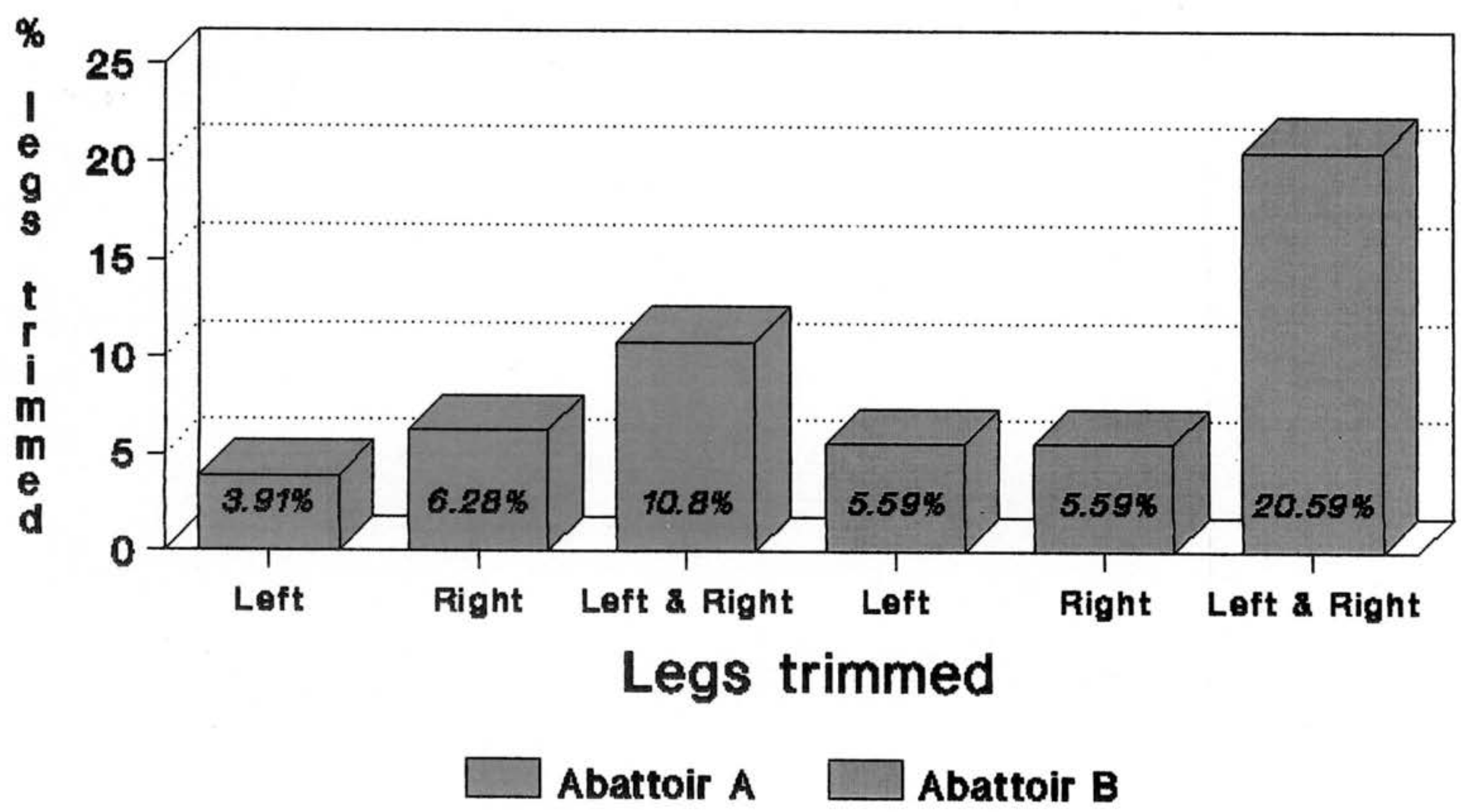
The cost of trimming could be divided into two main areas; namely time spent trimming and weight of tissue trimmed. The first cost is really a hypothetical one, as the meat inspectors are paid a salary irrespective of whether bursae are trimmed or not. However, it could be hypothesized that if the meat inspectors did not spend any time at all trimming, then the speed of the line could be increased. On the other hand, if the meat inspectors trimmed every bursa, as is their right, the line would be slowed considerably, thus increasing the cost of killing and dressing each pig.

The time taken to trim a bursa is made up of the following components:

[1] Examining the area in both legs
[2] Cutting off the bursa
[3] Throwing the bursae into receptacles

The first component was impossible to determine, since in many cases, the meat inspector was casually examining the carcase as it came along the line before he actually started cutting glands, etc. The mean bursitis score of the pigs in this study was slightly higher than the mean score for the large population of pigs examined in the abattoir study, so it could be assumed that the number of pigs trimmed on a national basis would be accordingly less. If the lower figure for trimming (equivalent to 16.6% of pigs in both legs) was taken as the national average in Scotland, then the number of legs trimmed would have been 127,680, as the total kill was approximately 798,000 pigs/annum. Thus, the minimal time taken to trim legs of pigs in Scotland would be approximately 109.94 hours. The cost of this time cannot be saved in wages but there could, however, be a hypothetical saving due to reduction in the time taken to kill and dress each pig if no trimming was carried out. This question was put to the meat inspectors themselves and the abattoir owners. The meat inspectors were adamant that bursae were only trimmed because time was occasionally available. The abattoir owners were enthusiastic about ideas for reducing the time taken to kill and dress a pig, but could not see how the improvement could be achieved without causing a great deal of friction amongst all the staff. On the other hand, however, if an EEC directive indicated that all adventitious bursae should be trimmed, then the lesion would cost the pig industry a significant amount of money due to more time spent on the line by each pig.

Fig 10.1 The % of pigs trimmed on the left leg, right leg or both legs in abattoirs A and B



Marchant (1984) calculated that 3% of condemned legs were condemned because of bursitis.

Conclusion

There was a significant and positive correlation between the number of bursae trimmed and the mean bursitis score. Both legs were trimmed more frequently than one leg only. The cost of trimming in 1991 was estimated to be approximately £6,079 and was mainly due to the value of the tissue trimmed or condemned.

Study 2

The cost of bursitis to the suppliers of breeding stock.

Introduction

Breeding pigs are commonly rejected by purchasers because of complaints regarding legs. Bursitis is a common cause of rejection of breeding stock for sale and usually comes under the description of 'lumps and bumps' by the selection officers or sales staff of breeding companies.

Objective

To assess the number of breeding pigs rejected because of bursitis and to estimate the cost to the industry.

Materials and Methods

The number of breeding stock rejected because of bursitis was estimated from the following information. In 1991, the number of breeding females and males in Scotland was nearly 47,000 and 3,000 respectively. (DAFS June Census). During the year, approximately 40% of breeding females were replaced with gilts (English et al, 1982). In Scotland, 85% of the boars and gilts required for breeding were provided by the pig breeding companies of which there were seven. None of the companies kept records of pigs with bursitis but all kept data regarding the number of pigs rejected for 'legs'. When pressed for an opinion, company personnel suggested that 'lumps and bumps' on the legs accounted for 45-75% of pigs rejected for leg problems. In addition 30 farmers who bred their own replacement gilts were questioned regarding their reasons for selection failure. The cost of bursitis to the suppliers of breeding stock was estimated using the data regarding the number of breeding pigs rejected and the average sale value of gilts and boars.

Results

The percentage of pigs rejected by each company interviewed is shown in Table 10.3.

Table 10.3: The percentage of gilts and boars rejected for leg problems

Company	% Rejected
A	75
B	45
C	70
D	60
E	55
F	65
G	70
Mean	62.8

During 1991, approximately 18,786 gilts entered the breeding herd and of these approximately 15,968 would have been supplied by the breeding companies. The selection rate of gilts presented varied between 62% and 82% (mean 69%) indicating that 8,440 were rejected. Of these 5,401 (63.99%) were rejected for leg problems. As the rejection rate for bursitis varied between 45 and 75% (mean 62.8%) it was estimated that approximately 3,392 gilts were rejected by the breeding companies because of bursitis. Farmers (30) who bred their own replacement gilts indicated that they selected between 45% and 70% (mean 54%) of gilts presented and of those rejected, bad legs accounted for 40-60% (mean 49%). This would mean that approximately 2,818 gilts were rejected by homebreeders and of these 1,176 were rejected because of 'legs'. Thus, it can be estimated that the number of gilts rejected by farmers, because of bursitis, was around 305, as they estimated that bursitis accounted for 20-30% (mean 26%) of the failures.

Therefore, during the year the total number of breeding females rejected because of bursitis would have been approximately 3,697.

None of the farmers bred their own boars and it was generally agreed that boars were usually bought from the few small pedigree herds left or mainly from the breeding companies. During 1991 approximately 1,000 boars entered the breeding herd. On this basis it was estimated 179 boars were rejected because of bursitis, as breeding company personnel indicated that the rejection rate was 42% (724) and of those, 75% (543) were rejected because of 'legs'. Of those rejected for 'legs', it was estimated that around 33% (179) were rejected because of bursitis.

Estimate of Costs

Gilts

The average price of a breeding gilt 1991 was £160.00 (Source MLC). Those rejected were sold as bacon pigs at a mean liveweight of 87.7 kg. Based on a killing out percentage of 76% and a price of 103p/kg/dead weight, each gilt carcase was worth £68.65 on average. The difference in price between a slaughter gilt and a gilt selected for breeding was approximately £91.35. However, the cost of extra food eaten by each selected gilt (sold at 110 kg) must be taken into consideration. Assuming a food conversion rate of 2.7:1 at this weight, each selected gilt would have eaten 60.2 kg of food which cost approximately £150/tonne. Thus, the cost of feed required for each gilt was £9.03. Therefore each gilt which failed selection would have reduced the farm income by £82.32. On a Scottish national basis, bursitis in female pigs would have cost the industry approximately £304,337 in total (£82.32 x 3697).

Boars

The boars rejected were culled at a mean liveweight of 91.6 kg with a killing out percentage of 73% and thus each carcase was worth £68.87 at 103p/kg dead weight. The selected boars were sold for £615 on average at a mean weight of 110 kg. Again the cost of growing the boars to 110 kg has to be considered. It was assumed that the food conversion ratio was around 2.6 so the extra feed required for each boar was approximately 47.84 kg. The value of this extra feed (£150/tonne) was £7.17 for each boar. The possible income lost per boar rejected was therefore £538.96 [£615 - (£7.17 + £68.87)]. On a national basis the total income lost through the rejection of boars for bursitis was approximately £96,474 (£538.96 x 179). The overall loss of income (males and females) was approximately £400,811.00. (These figures do not take into account the extra cost of housing the animals between 90 and 110 kg). It should be emphasised that these are potential losses, as there are occasions when the demand for breeding stock falls due to market forces and in this case selected gilts and boars have to be slaughtered as finished pigs. The costs are summarized in Table 10.4.

Table 10.4: Summary of bursitis costs

Cost of trimming	=	£ 3,156.25
Cost of condemnations	=	£ 2,923.14
Cost of rejection	=	£400,811.00
Total	=	**£406,890.39**

Discussion

In Chapter 7 it was noted that there was a significant and positive correlation between the severity of bursitis and foot-rot lesions. Observations at the abattoir suggested that individual pigs with bursitis were not lame if they were free of arthritis, but on the other hand there were more lame pigs or pigs with "awkward locomotion" in batches with high levels of bursitis. It was also established that there was no correlation between the severity of bursitis and growth rate. It could be postulated that conditions which cause severe bursitis and, at the same time, a high prevalence of foot-rot, might be responsible for economic loss related to lameness and interference with growth rate in some pigs. However, this would not be a loss due to the bursitis *per se.*

In a study examining the effects of slatted floors on claw lesions and performance, Newton et al (1980), noted that certain floors caused more claw lesions than others. However, there was no correlation with growth rate and the pigs performed equally well on both "*good and bad*" floors. In a trial in which foot-rot lesions were induced by housing the pigs on rough concrete, the pigs housed on the latter floor had significantly more foot lesions than those housed on smooth concrete. However, there was no significant difference in growth rate and food conversion efficiency between the pigs housed on rough or smooth floors (Wright et al, 1972). In neither of the above trials was the lesion of "bushfoot" (septic laminitis) produced and pigs with claw lesions were not observed to be lame. In the latter trial, the incidence of false sand-crack was not as high as that associated with field outbreaks of lameness (Penny et al, 1965; Penny, 1968).

In a field study of lameness associated with foot-rot lesions, Osborne (1950) noted that affected pigs were less profitable and quoted a loss of £1 3/8d per pig at that time (equivalent to 118 pence). Many of the pigs in this study had bushfoot lesions and it is highly probable that some of these would have had the added costs of treatment with antibiotics. Wright et al (1972) stated that the rough concrete surface used in their trials was *"certainly rougher than for floor surfaces likely to be encountered in most piggeries"*. It was the opinion of these workers that very severe lesions such as bushfoot were not produced because conditions under foot were not wet and dirty. In Chapter 3, it was noted that some floors which produced high levels of foot-rot lesions also led to more pigs with bursal erosions and in this case the concrete floors were not only very rough but also very wet and dirty as is commonly found in whey fed units. Thus, it could be concluded, that although similar conditions cause high levels of foot-rot and bursitis, it is only in a few exceptional cases that lameness leading to poor productivity and profitability will also be involved. Therefore, from an economic point of view, one cannot assume that because pigs have severe bursitis there will be indirect costs associated with foot-rot and lameness.

Although Marchant (1980), concluded that infection did not play a significant role in the pathogenesis of bursitis, he nevertheless reported finding bacteria in 34% of bursae at the abattoir, including coagulase positive staphylococci and streptococci. He stated that trimming bursae often led to fluid contents running down the flanks of the carcase and this could be a public health hazard and hence an indirect economic cost due to bursitis. Group G streptococci have been incriminated in some forms of sepsis in meat handlers but their significance was in doubt (McGregor 1978). Meat inspectors rarely sterilise a knife after trimming a bursa and there is no doubt that small puncture wounds and erosions lead to invasion by bacteria on occasions. However, it is impossible to quantify or assess the public health risk accurately. Nevertheless, while collecting data on bursitis, it was noted that one batch of pigs with no bursitis had a high prevalence of arthritis of the hock which caused the synovial sac to make a distinct bulge over the hock joint. The attention of the meat inspector was drawn to this lesion and he proceeded to trim the bulge as if it were a bursa! Large amounts of serosanguineous fluid ran down the side of every carcase so treated. However, it must be emphasised that this sort of occurrence was very rare. It is highly unlikely that the trimming of bursae constitutes a serious public health hazard and the assessment of this cost would be purely hypothetical.

Conclusion

Bursitis is a cost to the pig industry because of the formation of extra tissue which will not be consumed because of trimming or associated condemnation. There is an additional cost associated with rearing a proportion of gilts and boars which fail selection for breeding purposes and have to be sold as commercial pigs to the abattoir. Bursitis is not only unsightly but can also be minimised or prevented. The presence of bursae on the legs of intensively reared pigs might be thought by some persons to be indicative of a welfare problem. This aspect is examined and discussed in Chapter 11.

Chapter 11

GENERAL DISCUSSION, WELFARE ASPECTS AND PRINCIPAL CONCLUSIONS

Adventitious bursae on the hock and other areas of the limbs arise because of pressure over a bony prominence as a result of lying on hard floors, especially slatted concrete floors. Pigs do not appear to be aware of these bursae and these pigs with bursae grow equally as fast as those without. The behaviour of individual pigs contributed significantly to the number and distribution of bursae on the limbs and in many pigs individual bursae could reach the size of a large apple. Members of the public might genuinely enquire if it is right to raise pigs in conditions which cause large calluses on their limbs. After all, the condition does not exist in the wild pig and hence it may be argued that bursitis is unnatural and must therefore be *"anti-welfare"*. Welfare is defined in the Oxford Advanced Dictionary of Current English as *"condition of having good health, comfortable living and working conditions"*. Broom (1989) extended that concept when he stated *"the welfare status of an animal relates to its attempts to cope with its environment"*. If we consider bursitis strictly within the limits of these definitions it should be borne in mind that the first definition related to the welfare of humans not animals.

During this study it was noted that the state of the animal's health had no relationship to bursitis. Indeed, two of the farms which came high in the bursitis league table were minimal disease units which had few health problems. The perception of comfort is easy to understand from a human point of view, but how does the pig perceive comfort? It is highly likely that a pig, with or without bursitis, would be uncomfortable in a cold draught on a bedded floor. One of the most surprising observations made during the housing study concerned pigs housed in a deep-strawed court. The feeding bins were placed on a raised concrete-slatted plinth and the same pigs persisted in lying on the concrete slats instead of the deep straw bedding available. These pigs came from an intensive unit with slatted floors and had a high prevalence and severity of bursitis on arrival. It was suggested that these particular pigs lay on the slats because they wished to be near the feed trough. However, when extra feed troughs were placed on the straw the same phenomenon occurred with every batch of pigs. One might argue that these pigs which persistently lay on the slats had an imprinted behaviour, but this does raise our perception of what we understand to be 'comfortable' for the pig. Broom (1989), stated that there was a range of indicators of poor welfare "*including what animals choose when given the opportunity*". In relation to the second definition of welfare there was no indication that pigs with bursitis had difficulty coping with their environment. If anything, the pigs with bursitis seemed to prefer lying on the floor more than their contemporaries. If they had preferred standing to lying on a hard floor, it is highly unlikely that any would have developed bursitis.

Thus, if bursitis is considered in light of the present definitions of welfare, it would not appear to be a welfare problem. However, the welfare debate has moved significantly outwith the strict terms of the definitions. Two of the provisions highlighted in the preface to the Code of Recommendations for the Welfare of Livestock Pigs (1983) are:

- flooring which neither harms the animals, nor causes undue strain
- the prevention, or rapid diagnosis and treatment, of vice, injury, parasitic infestation and disease.

If bursitis can be described as an injury then it must, by definition, be an indicator of poor welfare. However, the term injury in its true sense is not quite applicable in this context. The pig welfare consultative panel set up by the British Society of Animal Production, identified four categories of animal welfare. One category related to the avoidance of conditions leading to skin abrasions, injury, deformity and vice. The panel agreed that this category constituted cruelty to animals and as such could not be tolerated. The question raised is "could bursitis be described as a deformity". A deformity is defined as an unnaturally shaped part of the body in the Oxford English Dictionary and to this extent bursitis does change the shape of the hock or leg, but it does however, arise through a **natural** reaction of the body tissues.

Oldham (1989), was of the opinion that in order to achieve the best overall welfare, there has to be compromise. Indeed the housing system which induces most bursitis, i.e. total concrete slats, has many advantages over bedded systems, which may have facets detrimental to good welfare (Taylor 1983). However, on the other hand, floor systems which cause high levels of bursitis also tend to cause a high prevalence of foot-rot lesions.

It was noted that pigs with induced foot-rot lesions were not lame (Wright et al, 1972) and this finding was substantiated during this study.

Nevertheless, the question must be asked if it can be morally acceptable to keep pigs on floors which cause both foot-rot lesions and bursitis. Irrespective of whether it constitutes bad welfare or not, it is highly unlikely that the public would support such a system.

Even the Straw-Flow System, described as a high welfare system and supported by the Royal Society for the Prevention of Cruelty to Animals will not prevent the development of bursitis in many pigs. Bursitis is neither painful nor harmful to the pig, and it has to be concluded, that a moderate degree of bursitis (a blemish) is an acceptable result of rearing pigs intensively in the overall interests of their welfare.

Principal Conclusions

In Chapter 1 it was noted that adventitious bursitis was recognised in most countries where pigs were reared intensively. The majority of workers concluded that hard floors played a significant role in the development of bursitis. Although millions of pigs have been reared in the USA, there were no reports of bursitis from that country. The highest prevalence of bursitis was reported from Germany in 1990.

In Chapter 2 it was shown that the prevalence and severity of bursitis in Scottish pigs was high. Male pigs tended to develop bursitis to a greater extent than females, while the prevalence and severity of bursitis in males and females was higher in winter than in summer. As farm size and hence output rose, the prevalence and severity of bursitis also rose, implying that more intensive conditions are usually present on large farms. Bursae (apart from capped hock) were found on three main aspects of the hock, namely, in the plantar, lateroplantar or medial aspect. When capped hock was present, bursitis on other aspects of the hock was less severe. There was a higher prevalence of bursae with dermal erosions in pigs from large farms especially when the pigs were reared on abrasive concrete floors. When the prevalence and severity of hock bursitis was high, bursae on the forelegs were frequently noted.

In Chapter 3 it was shown that infection did not play a role in the development of bursae. Bursal fluids contained few cells and these were mainly degenerating red cells and lymphocytes. Bursae were found to develop over specific bony prominences in both fore and hind limbs. As bursae aged they tended to become harder because of the accumulation of fibrous tissue. It was suggested that bursae began with the exudation of fluid and fibrin from traumatised capillaries and lymphatics in the subcutaneous connective tissue.

In Chapter 4 it was shown that pigs with a high prevalence and severity of bursitis came from farms with hard floors, frequently, slatted concrete floors. Stocking density was shown to have an effect on bursitis over and above the floor affect.

Studies described in Chapter 5 showed that bursitis started to develop in suckling piglets if the farrowing floor was hard. The provision of deep bedding prevented bursitis arising. However, data presented in Chapter 6 showed that the depth of straw bedding used in the high welfare Straw-Flow system was not enough to prevent the development of bursitis. However, very deep straw systems and the deep sawdust-enzyme-system not only prevented bursitis arising but also allowed bursae already present to resolve markedly.

In Chapter 7 data were presented which showed that there was a significant and positive correlation between the severity of foot-rot and bursitis of the hock.

Data presented in Chapter 8 showed that coloured pigs were less likely to develop bursitis when reared on the same floors as white pigs. The heritability of bursitis was estimated to be 0.25.

Other factors such as the level of subcutaneous fat and skin thickness were shown to play a role in the development of bursitis and the data collected were presented in Chapter 9. In Chapter 10 it was shown that bursitis was a significant cost to the pig industry. The cost was mainly due to rejection of breeding stock, bursal trimming and associated condemnations.

Finally, it was argued that bursitis was neither painful nor did it have an adverse effect on growth rate. It was concluded that a moderate degree of bursitis (a blemish) was an acceptable result of rearing pigs intensively.

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Appendix 2.1: The number of pigs examined in winter and summer, sex and mean bursitis score

No. of pigs

Sex	Winter	Summer	Total
M	5061	2289	7350
F	4656	2040	6696
Total	9717	4329	14046

Mean bursitis score

Sex	Winter	Summer	Mean score
M	1.663	1.509	1.615
F	1.641	1.438	1.579
Mean score	1.652	1.476	1.598

Appendix 2.2: Tabulation of small, medium and large farms according to bursitis score.

All farms (146)

	-	0.90	31 ****************
0.90	-	1.90	83 **
1.90	-	2.90	32 ****************
2.90	-	4.00	0
4.00	-		0

Scale: 1 asterisk represents 2 units.

Small farms (46)

	-	0.4	8 ********
0.4	-	0.8	6 ******
0.8	-	1.2	10 **********
1.2	-	1.6	11 ***********
1.6	-	2.0	9 *********
2.0	-	2.4	1 *
2.4	-		1 *

Scale: 1 asterisk represents 1 unit.

Medium farms (47)

	-	0.4	3 ***
0.4	-	0.8	8 ********
0.8	-	1.2	7 *******
1.2	-	1.6	9 *********
1.6	-	2.0	15 ***************
2.0	-	2.4	4 ****
2.4	-		1 *

Scale: 1 asterisk represents 1 unit.

Large farms (53)

	-	0.4	1 *
0.4	-	0.8	1 *
0.8	-	1.2	2 **
1.2	-	1.6	12 ************
1.6	-	2.0	17 *****************
2.0	-	2.4	16 ****************
2.4	-		4 ****

Scale: 1 asterisk represents 1 unit.

Appendix 2.3: Tabulation of bursal distribution in either leg in winter and summer.

No. of pigs with plantar bursitis

Leg	**Winter**	**Summer**	**Total**
Neither	1990	1219	3209
Left	638	442	1080
Right	679	395	1074
Both	6410	2273	8683
Total	9717	4329	14046

%. of pigs with plantar bursitis

Leg	**Winter**	**Summer**	**Total**
Neither	14.17	8.68	22.85
Left	4.54	3.15	7.69
Right	4.83	2.81	7.65
Both	45.64	16.18	61.82
Total	69.18	30.82	100.00

No. of pigs with lateroplantar bursitis

Leg	**Winter**	**Summer**	**Total**
Neither	8146	3337	11483
Left	466	271	737
Right	427	327	754
Both	678	394	1072
Total	9717	4329	14046

Appendix 2.3 (Cont'd.)

% of pigs with lateroplantar bursitis

Leg	**Winter**	**Summer**	**Total**
Neither	58.00	23.76	81.75
Left	3.32	1.93	5.25
Right	3.04	2.33	5.37
Both	4.83	2.81	7.63
Total	69.18	30.82	100.00

No. of pigs with medial bursitis

Leg	**Winter**	**Summer**	**Total**
Neither	8761	3677	12438
Left	222	169	391
Right	293	254	547
Both	441	229	670
Total	9717	4329	14046

% of pigs with medial bursitis

Leg	**Winter**	**Summer**	**Total**
Neither	62.37	26.18	88.55
Left	1.58	1.20	2.78
Right	2.09	1.81	3.89
Both	3.14	1.63	4.77
Total	69.18	30.82	100.00

Appendix 2.4: Three-way tables showing the distribution of all the bursae on the left or right legs.

Left leg (No. of pigs)

	flm	0.00	1.00	Total
flp	fllp			
0.00	0.00	2467	121	2588
	1.00	1575	120	1695
	Total	4042	241	4283
1.00	0.00	8842	807	9649
	1.00	101	13	114
	Total	8943	820	9763
Total	0.00	11309	928	12237
	1.00	1676	133	1809
	Total	12985	1061	14046

flp = plantar flm = medial
fllp = lateroplantar

Left leg (% of pigs)

	flm	0.00	1.00	Total
flp	fllp			
0.00	0.00	17.56	0.86	18.43
	1.00	11.21	0.85	12.07
	Total	28.78	1.72	30.49
1.00	0.00	62.95	5.75	68.70
	1.00	0.72	0.09	0.81
	Total	63.67	5.84	69.51
Total	0.00	80.51	6.61	87.12
	1.00	11.93	0.95	12.88
	Total	92.45	7.55	100.00

flp = plantar flm = medial
fllp = lateroplantar

Appendix 2.4 (Contd.)

Right leg (No. of pigs)

		rtleg		
	frm	0.00	1.00	Total
frp	frlp			
0.00	0.00	2488	135	2623
	1.00	1524	142	1666
	Total	4012	277	4289
1.00	0.00	8675	922	9597
	1.00	142	18	160
	Total	8817	940	9757
Total	0.00	11163	1057	12220
	1.00	1666	160	1826
	Total	12829	1217	14046

flp = plantar flm = medial
fllp = lateroplantar

Right leg (% of pigs)

	frm	0.00	1.00	Total
frp	frlp			
0.00	0.00	17.71	0.96	18.67
	1.00	10.85	1.01	11.86
	Total	28.56	1.97	30.54
1.00	0.00	61.76	6.56	68.33
	1.00	1.01	0.13	1.14
	Total	62.77	6.69	69.46
Total	0.00	79.47	7.53	87.00
	1.00	11.86	1.14	13.00
	Total	91.34	8.66	100.00

flp = plantar flm = medial
fllp = lateroplantar

Appendix 2.5: The number of pigs from each farm with (score 5) and without bursae, in small, medium and large output farms.

Farm ID	No. of pigs without bursitis	No. of pigs with bursitis (score 5)	Total
Small farms (46)			
F1	8	0	8
C1	25	0	25
C1	9	0	9
J1	7	0	7
C1	68	0	68
S1	85	1	86
C2	10	0	10
S2	9	0	9
P2	39	0	39
S3	139	0	139
B4	56	1	57
A5	11	0	11
J5	6	0	6
T5	78	0	78
P5	67	0	67
MU	6	0	6
HA	9	0	9
AD	13	0	13
BU	14	0	14
DL	14	0	14
GA	16	0	161
NS	19	0	19
NS	22	0	22
BD	23	0	23
GR	27	0	27
MA	30	4	34
SP	30	0	30
RE	31	0	31
DL	33	0	33
HD	34	0	34
WG	42	0	42
DA	42	0	42
OA	55	2	57
BO	63	0	63
MI	63	0	63
TO	64	2	66
MF	65	0	65
BA	66	0	66
MC	67	1	68
NS	69	0	69

Appendix 2.5 (Contd.)

Farm ID	No. of pigs without bursitis	No. of pigs with bursitis (score 5)	Total
Small farms (46) (Contd.)			
NE	71	1	72
NS	87	0	87
NO	89	0	89
KI	95	0	95
DL	110	0	110
AT	165	0	165
Medium Farm (47)			
D0	63	0	63
W1	98	3	101
D1	132	0	132
S1	204	2	206
J1	36	0	36
J1	33	0	33
L1	120	0	120
M1	51	0	51
S1	155	0	155
B3	188	2	190
L3	77	0	77
F3	105	2	107
A4	48	0	48
N4	52	0	52
D4	131	1	132
F4	42	0	42
5F	90	0	90
H5	123	1	124
J5	31	1	32
10	43	1	44
NS	14	0	14
15	72	0	72
AY	18	0	18
NS	22	0	22
GI	42	0	42
LU	44	0	44
JG	45	0	45
FO	47	0	47
BB	54	1	55
NS	56	1	57
CO	62	2	64

Appendix 2.5 (Contd.)

Farm ID	No. of pigs without bursitis	No. of pigs with bursitis (score 5)	Total
Medium Farm (47) (Contd.)			
GR	64	0	64
CH	73	0	73
BD	75	0	75
WS	80	1	81
PM	90	1	91
VY	90	1	91
WS	97	0	97
BH	106	3	109
AL	113	0	113
DL	114	2	116
MO	117	0	117
MA	125	1	126
BA	129	1	130
FB	144	0	144
TS	147	0	147
BB	163	0	163
Large farms (53)			
UY	113	3	116
BA	133	0	133
AR	210	3	213
BB	184	0	184
CK	67	0	67
BB	253	1	254
CO	216	0	216
CA	128	3	131
F5	222	0	222
DS	251	4	255
G7	147	0	147
FE	188	0	188
KE	150	1	151
H3	45	1	46
LA	49	0	49
HF	274	3	277
N5	48	0	48
K1	89	2	91
NF	188	2	190

Appendix 2.5 (Contd.)

Farm ID	No. of pigs without bursitis (score 5)	No. of pigs with bursitis (score 5)	Total
Large farms (53) (Contd.)			
N3	119	0	119
P1	159	5	164
P4	160	0	160
Y8	145	0	145
SC	123	1	124
PE	71	1	72
VI	266	11	277
AD	79	3	82
X0	126	1	127
DD	72	1	73
AE	182	2	184
MO	169	1	170
AE	94	0	94
N5	112	0	112
MR	73	4	77
GA	148	2	150
WK	165	2	167
GG	223	1	224
WY	32	0	32
MI	35	1	36
J3	271	2	273
ST	145	0	145
M1	246	8	254
WB	193	3	196
SH	121	5	126
DR	39	0	39
RR	106	0	106
DC	471	2	473
CA	63	0	63
H2	86	0	86
SB	150	3	153
PI	90	0	90
SL	174	1	175
SP	82	3	85
Total	13921	125	14046

Appendix 2.5 (Contd.)

******* Regression Analysis *******

Response variate	:	yy
Binomial totals	:	c[3]
Distribution	:	Binomial
Link function	:	Logit
Fitted terms	:	Constant, davscore

***** Summary of analysis *****

	d.f.	Deviance	Mean deviance Deviance	Ratio
Regression	1	45.6	45.626	38.94
Residual	144	168.7	1.172	
Total	145	214.3	1.478	

* MESSAGE: The following units have large standardized residuals:

52	2.71

* MESSAGE: The following units have high leverage:

103	0.204
129	0.060
136	0.135
138	0.062
140	0.044

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	-6.970	0.431	-16.18
davscore	1.278	0.220	5.80

Appendix 2.6: The number of pigs with capped hock in one, both or neither leg(s) in winter and summer.

No. of pigs with capped hock

Leg	Winter	Summer	Total
Neither	9425	4226	13651
Left	52	31	83
Right	33	18	51
Both	207	54	261
Total	9717	4329	14046

% of pigs with capped hock

Leg	Winter	Summer	Total
Neither	67.10	30.09	97.19
Left	0.37	0.22	0.59
Right	0.23	0.13	0.36
Both	1.47	0.38	1.86
Total	69.18	30.82	100.00

No. of pigs with capped hock (male and female)

Leg	Male	Female	Total
Neither	7087	6564	13651
Left	57	26	83
Right	32	19	51
Both	174	87	261
Total	7350	6696	14046

% of pigs with capped hock (male and female pigs)

Leg	Male	Female	Total
Neither	50.46	46.73	97.19
Left	0.41	0.19	0.59
Right	0.23	0.14	0.36
Both	1.24	0.62	1.86
Total	52.33	47.67	100.00

Appendix 2.6 (Contd.)

The number and % of pigs with capped hock from low, medium and high scoring farms.

No. of pigs with capped hock

Leg	Low	Medium	High	Total
Neither	2152	4678	6821	13651
Left	10	22	51	83
Right	3	19	29	51
Both	14	112	135	261
Total	2179	4831	7036	14046

% of pigs with capped hock

Leg	Low	Medium	High	Total
Neither	15.32	33.30	48.56	97.19
Left	0.07	0.16	0.36	0.59
Right	0.02	0.14	0.21	0.36
Both	0.10	0.80	0.96	1.86
Total	15.51	34.39	50.09	100.00

Appendix 4.1: Statistical analysis: Relationship between floor hardness/softness and bursitis score.

******* Regression Analysis *******

Response variate	:	score
Fitted terms	:	Constant, fls

***** Summary of analysis *****

	d.f	s.s.	m.s.	v.r.
Regression	1	11.720	11.7200	94.20
Residual	27	3.359	0.1244	
Total	28	15.079	0.5385	
Change	-1	-11.720	11.7200	94.20

Percentage variance accounted for 76.9

* MESSAGE: The following units have large standardized residuals:

1	2.81
17	-2.32

* MESSAGE: The following units have high leverage:

27	0.178
29	0.192

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	0.8596	0.0784	10.96
fls	1.174	0.121	9.71

Regression Equation

/Bursitis score = 0.86 + 1.17 x floor score

Appendix 4.1 (Contd.)

******* Regression Analysis *******

Response variate	:	sscore
Fitted terms	:	Constant, fls

***** Summary of analysis *****

	d.f.	s.s.	m.s.	v.r.
Regression	1	3.3238	3.32383	122.27
Residual	27	0.7340	0.02718	
Total	28	4.0578	0.14492	
Change	-1	-3.3238	3.32383	122.27

Percentage variance accounted for 81.2

* MESSAGE: The following units have large standardized residuals:

1	2.15
17	-2.23

* MESSAGE: The following units have high leverage:

27	0.178
29	0.192

***** Estimates of regression coefficients *****

	estimate	s.e.	t
Constant	0.8440	0.0366	23.03
fls	0.6254	0.0566	11.06

Regression Equation

/Bursitis score = 0.84 + 0.625 floor score

Appendix 4.2: Pigs with high mean scores

Description of Housing

Farm A: Mean Bursitis Score 2.647

The farrowing houses in this farm had pens with floors of part solid concrete, part flat metal rods. After reaching 6-7 kg, weaned pigs were moved to flatdecks with floors made partly of expanded metal and partly flat metal rods. After leaving the flatdecks at 22 kg, gilts were housed in lightly strawed pens with an outside solid concrete dunging area. However, the boars were first moved to a pyramid house with fully slatted concrete floors until 50 kg and then transferred to the final finishing accommodation in which the floor was wholly composed of concrete slats.

Farm B: Mean Bursitis Score 2.339

In this case, the farrowing pen floors were made of part solid concrete, part punched metal slats. At 5.5 kg, the weaners were then housed in kennels with a solid concrete floor in the lying area and expanded metal in the dunging area, to 20 kg liveweight. The rearing pigs were then housed in pens with floors of part solid concrete (lying) and part concrete slats (dunging area). At 30 kg, the finishing pigs were housed in pens similar to those of the last housing section, till slaughter.

Farm C: Mean Bursitis Score 2.164

In this Farm, 80% of farrowing pens had floors made of part woven wire and part wood (floor of the creep). The remaining pens had floors of solid concrete but the creep area had a light covering of shavings. Both the first and second stage flatdecks had floors made of plastic slats. At around 30 kg the pigs were then either moved to pens with floors of part solid concrete/part concrete slats (dunging area) till slaughter, or wholly made of plastic slats.

Farm D: Mean Bursitis Score 2.110

In this Farm the piglets were born in farrowing pens with floors made of part solid concrete, part cast iron slats. After weaning, all pigs were then transferred to flatdecks with floors either wholly made of plastic slats or expanded metal. At approximately 18 kg, the growing pigs were then housed in second stage flatdecks with expanded metal floors. At around 30 kg liveweight, the pigs were housed in pens with floors made wholly of concrete slats until slaughter.

Farm E: Mean Bursitis Score 2.023

The farrowing pens had floors of part solid concrete, part plastic slats. At weaning (6 kg) the pigs were moved to first stage flatdecks with floors wholly made of plastic slats similar to those in the farrowing house. At 21 kg, the pigs were then moved to second stage flatdecks with floors again made of slats covered in plastic. From 40-70 kg liveweight, the pigs were housed in deep strawed pens with concrete floors. For finishing between 70-90 kgs, the pigs were housed in pens with floors of part solid concrete (lying area) and part concrete slats (dunging area).

Farm F: Mean Bursitis Score 2.017

In this case the piglets were born in farrowing pens with floors mainly made of woven wire and part solid concrete (creep area). After weaning at 5 kg liveweight, the pigs were reared in first stage flatdecks with expanded metal floors to around 30 kg after which time they were transferred to second stage flatdecks again with floors wholly made of expanded metal. Finally the pigs were moved at 35 kg to a finishing house with floors wholly made of concrete slats.

Farm G: Mean Bursitis Score 2.000

On this farm, piglets were farrowed in a pen with a floor made of part solid concrete, part concrete slats and part expanded metal. First and second stage weaners were housed in flatdecks with expanded metal floors in each case. At approximately 35 kg liveweight pigs were transferred to a Brian Thomas house with concrete floors inside the kennels and expanded metal floors in the outside dunging area. After reaching 60 kg liveweight, the pigs were reared in pens with a solid concrete resting area and concrete slatted dunging area until 90 kg.

Farm H: Mean Bursitis Score 1.995

The farrowing house pens had floors made of three materials: solid concrete, punched metal and cast iron slats. After weaning at approximately 6 kg liveweight, pigs were transferred to flatdecks with floors wholly constructed of cast iron slats. At 10 kg liveweight, weaners were then housed in flatdecks with floors made of expanded metal. After reaching approximately 20-25 kg the pigs were then moved into flatdecks with floors made entirely of round metal rods. On 40 kg, the pigs were reared in pens with fully slatted concrete floors until slaugher at 90 kg.

Farm I: Mean Bursitis Score 1.891

In this particular farm, the floors and farrowing houses were part solid concrete, part expanded metal. Piglets were weaned around 6 kg and then moved to first stage flatdecks with floors of expanded metal but with one area covered with a rubber mat. At 12 kg, the weaners were moved to kennels with a solid concrete lying area and expanded metal dunging area. At around 30 kg, the pigs were then housed in pens with part solid concrete floors, part concrete slats in the dunging area to finishing at 90 kg.

Farm J: Mean Bursitis Score 1.730

In this case, piglets were farrowed in pens with floors made of solid concrete but with a fairly liberal amount of straw. Sow and piglets were shifted after one week to pens with floors of part solid concrete and part woven wire. After weaning at around 7.5 kg piglets were moved to weaner kennels with floors made of part solid concrete and part flat metal bars. After reaching 22 kg pigs were shifted to a second stage flatdeck with floors made of flat metal bars. On reaching 30 kg the pigs were transferred to the finishing section with floors made of part solid concrete and part concrete slats.

Appendix 4.3: Pigs with medium mean scores

Description of Housing in Appendix 3

Farm A: Mean Bursitis Score 1.449

Piglets were farrowed in pens with floors made of part solid concrete/part expanded metal. After weaning at 7 kg liveweight the weaners were moved to first stage flatdecks where the floors were made of part expanded metal partly overlain with a rubber mat. At 18 kg liveweight the pigs were then moved to kennels with floors of part solid concrete, part concrete slats. After reaching 33 kg, gilts only were moved to pens with part solid, part concrete slatted floors until 50 kg liveweight, while the boars, after reaching 40 kg, were moved to pens with similar floors but of different dimensions. After 50 kg liveweight the gilts were finally moved to finishing accommodation in deeply strawed courts.

Farm B: Mean Bursitis Score 1.443

On this farm, piglets were farrowed in two slightly different farrowing Farms. In one type, the floors were of solid concrete with a good covering of straw while in the other, the floors were made of part solid concrete with a light covering of straw and part round metal slats. After weaning at around 6.5 kg liveweight the piglets were moved to weaner kennels with floors made of part solid concrete overlaid with light straw bedding. After reaching 12 kg the piglets were moved to flatdecks with floors made of plastic slats. On reaching 30 kg liveweight, the rearing pigs were then moved to pens with floors of part solid concrete overlaid with light straw bedding in the lying area and part solid concrete dunging area. Finally, when pigs reached 50 kg they were placed in pens with floors made of part solid concrete lightly overlaid with straw and part concrete slats in the dunging area.

Farm C: Mean Bursitis Score 1.380

In this Farm, piglets were farrowed in pens with floors made of part solid concrete, part flat metal rods. After weaning at 6 kg liveweight, the pigs were moved to flatdecks with floors entirely made of woven wire. On reaching 15 kg the weaners were then housed in second stage flatdecks with floors made wholly of woven wire. Growing pigs were then transferred at 27 kg liveweight to deeply strawed courts with a small concrete dunging area which had a light covering of straw. From 55 kg onwards the pigs were housed in pens with solid concrete floors but with a light covering of straw in the lying area.

Farm D: Mean Bursitis Score 1.360

The farrowing pens in this Farm had floors constructed of part concrete covered with deep straw in the creep area, part solid concrete and part concrete slats in the dunging area. After weaning at 6 kg, the piglets were moved to kennels with part concrete, part round metal rod floors. However, the concrete was covered in shavings for the first day only and this bedding lasted for 3-5 days. After reaching 12 kg liveweight, the pigs were then housed in pens with floors of part solid concrete, part expanded metal. Sometimes shavings were scattered on the concrete but more often they were not. At 50 kg liveweight the pigs were moved to pens with floors of solid concrete. Shavings were used occasionally but certainly never routinely. After a short time in this accommodation, the pigs were moved at 15 kg liveweight to pens with floors of part solid concrete, part concrete slats until 45 kg liveweight was reached. After this, the gilts were housed in deep strawed pens until slaughter, while the boars were housed in pens with floors of part solid concrete, part concrete slats.

Farm E: Mean Bursitis Score 1.327

Two designs of farrowing quarters were used on this farm. In one, the floors were composed of part solid concrete, part cast iron slats, while in the other, the pens had floors wholly made of solid concrete but with a reasonable cover of chopped straw. However, bare concrete patches could be seen from time to time. After reaching 4.5 kg liveweight, the pigs would be moved to either flatdecks with floors of plastic slats or flatdecks with floors of woven wire mesh. On reaching 15 kg liveweight, growing pigs were then transferred to pens with floors of part solid concrete, part concrete slats. For finishing, pigs were either transferred at 25 kg to a deep strawed yard from which some were finished while others were transferred at 70 kg to pens with floors of part solid concrete, part concrete slats.

Farm F: Mean Bursitis Score 1.267

In this Farm, the pigs were bought in as 25 kg weaners which had been reared on hard floors since birth. On entering the farm, they were housed in one of two deep strawed courts or in pens with floors of part solid concrete, part concrete slats. For finishing, all pigs were transferred at 60 kg to pens with floors of part solid concrete, part concrete slats.

Farm G: Mean Bursitis Score 1.200

The farrowing houses in this case were either outside arks deeply bedded with straw and outside earth runs, or inside pens with a concrete floor deeply covered in straw. After weaning at 12 kg liveweight, the pigs were moved into pens with part solid concrete covered in sawdust, part solid concrete. Occasionally some pigs might be finished from this type of pen, otherwise pigs of 40 kg would be transferred to a pen with similar floor design until slaughter.

Farm H: Mean Bursitis Score 1.22

The farrowing pens were of two types. The floors of the first were made entirely of woven wire mesh, while in the second floors were made of part solid concrete, part round metal bars. After weaning at 7 kg the pigs were moved either to a piggy box with an aluminium slatted floor, or to flatdecks with floors of part solid concrete, part expanded metal. At 14 kg the weaners were housed in kennels with part solid concrete floors with a thin covering of straw and part solid concrete in the dunging area. After reaching 25 kg the growing pigs were transferred to flatdecks with expanded metal floors. Pigs could either be finished in pens with floors of part solid concrete with a thin layer of straw and part solid concrete in the dunging area or in pens with part solid concrete, part concrete slats. However, during the period of the abattoir survey, an unspecified number of pigs had been reared in deep straw from 20-90 kg on a neighbouring farm.

Farm I: Mean Bursitis Score 1.087

Farrowing houses in this Farm had pens with floors of part solid concrete, part flat metal rods. After weaning at 7 kg the pigs were transferred to first stage flatdecks with floors of part solid concrete, part flat metal rods. After reaching 15 kg, the pigs were transferred to second stage flatdecks with floors of part solid concrete, part expanded metal. Finishing pigs, from 50 kg onwards were housed in pens with a solid concrete floor but with some straw bedding in the lying area. Bare patches of concrete could be seen from time to time.

Farm J: Mean Bursitis Score 1.043

In this Farm, pigs were born in a farrowing pen with floors of part concrete, covered in deep shavings, and part wood. They were then moved to a follow-on pen with a floor of solid concrete covered with a thin layer of sawdust. At 8 kg liveweight the pigs were moved to pens with floors of solid concrete with a light layer of straw. Bare patches could be seen. At 25 kg they were moved to deep strawed kennels with an outside solid concrete dunging area. At 50 kg the pigs were moved to finishing accommodation in which the floors were made of solid concrete covered by a reasonably deep layer of straw, apart from the dunging area.

Appendix 4.4: Pigs with low mean scores

Description of Housing

Farm A: Mean Bursitis Score 0.905

The piglets in this Farm were born in farrowing pens with solid concrete floors and a covering of straw and then moved to a follow-on pen with similar floors. At 8 kg liveweight the piglets were transferred to kennels with floors of solid concrete apart from the lying area which had a covering of straw. After reaching 15 kg the pigs were then housed in pens with floors of solid concrete and a straw covering. From 40 kg onwards the pigs were finished in pens with floors of solid concrete and a straw covering. Frequently, the floors were bare of bedding by the morning.

Farm B: Mean Bursitis Score 0.855

The farrowing pens in this Farm had floors of part solid concrete, part expanded metal. At 6.5 kg the weaners were then housed in kennels with floors of part asbestos sheets part plastic slats. At 15 kg the pigs were then transferred to follow on pens with floors of part solid concrete, part expanded metal. At 45 kg the pigs were then finished in deep strawed courts.

Farm C: Mean Bursitis Score 0.782

Farrowing houses in this Farm had floors of part solid concrete, part plastic slats. After weaning pigs remained in the farrowing pens to 17 kg after which they were transferred to either a deep strawed court or a deep strawed court with a narrow raised concrete area for feeding and watering. After reaching 70 kg pigs were finished in pens with floors of part solid concrete, part concrete slats.

Farm D: Mean Bursitis Score 0.588

In the farrowing houses, pigs could be houses in pens with floors of part solid concrete and part expanded metal or part woven wire or part round metal rods. At 5.5 kg they were then transferred first stage flat decks with floors made wholly of expanded metal. At 15 kg the pigs were transferred to pens with mainly part slatted concrete floor and part solid concrete. At 25 kg they were then finished in deeply strawed courts.

Farm E: Mean Bursitis Score 0.377

In this Farm the piglets were born in pens with floors of solid concrete covered with straw and then moved to follow on pens with floors of part solid concrete, part round metal rods. After reaching 7.5 kg the weaners were housed in kennels with floors of part solid concrete, part round metal rods. At 22 kg the pigs were moved to pens with floors of round metal rods apart from a small area of solid concrete in the feeding area. The pigs were then finished from 50 kg in deep strawed courts.

Farm F: Mean Bursitis Score 0.358

This Farm bought in weaners from another farm where they were reared in farrowing pens with part solid concrete floors and part flat metal rods. They were placed in kennels with floors of part solid concrete, part expanded metal and then finished in deep strawed courts.

Farm G: Mean Bursitis Score 0.316

The farrowing pens in this Farm were of a similar design and the floors were all part solid concrete/part expanded metal. After reaching 7 kg the weaners were housed in first stage flatdecks where the floors consisted of part rubber mat over concrete/part expanded metal. On reaching 18 kg the pigs were then transferred to kennels with floors of part solid concrete, part concrete slats. When most of the pigs had reached 35 kg liveweight they were housed in one of two strawed courts. The remainder were finished in the kennel to bacon weight.

Farm H: Mean Bursitis Score 0.190

In this Farm the farrowed sows were transferred after one week to follow on pens. The first pen had floors of part solid concrete, part wood with a liberal covering of straw. The follow on pens had floors of solid concrete covered with straw. On reaching 7 kg the weaners were moved to pens with floors of solid concrete covered in deep straw. The farmer stated that on a few occasions he had seen bare concrete floors in three pens.

Farm I: Mean Bursitis Score 0.087

In this Farm piglets were farrowed in pens with part solid concrete, part wooden floors covered by a layer of straw. Piglets were then moved to a pen with a concrete floor and deep straw bedding. The straw tended to spread into the solid concrete dunging area.

The sow was moved out at weaning, leaving the 10 kg piglets in the same accommodation. At 20 kg liveweight the pigs were moved to deep strawed courts where they were housed until slaughter.

Farm J: Mean Bursitis Score 0.062

This Farm was similar in most ways to Farm I. Again the farrowing pens had floors of part solid concrete, part wood with a liberal covering of straw. Sows and litters were then moved to pens with floors of solid concrete and deep straw. The sow was weaned when the piglets reached 18 kg but the piglets were left in the pen until 30 kg at which stage they were transferred to the final finishing accommodation in deeply strawed courts.

Appendix 4.5: Statistical analysis: Relationship between floor score, stocking density and bursitis score.

******* Regression Analysis *******

Response variate	:	sscore
Fitted terms	:	Constant, fls, sd

***** Summary of analysis *****

	d.f.	**s.s.**	**m.s.**	**v.r.**
Regression	2	3.4617	1.73083	75.49
Residual	26	0.5961	0.02293	
Total	28	4.0578	0.14492	
Change	-1	-0.1378	0.13783	6.01

Percentage variance accounted for 84.2

* MESSAGE: The following units have high leverage:

1	0.22
27	0.22
29	0.22

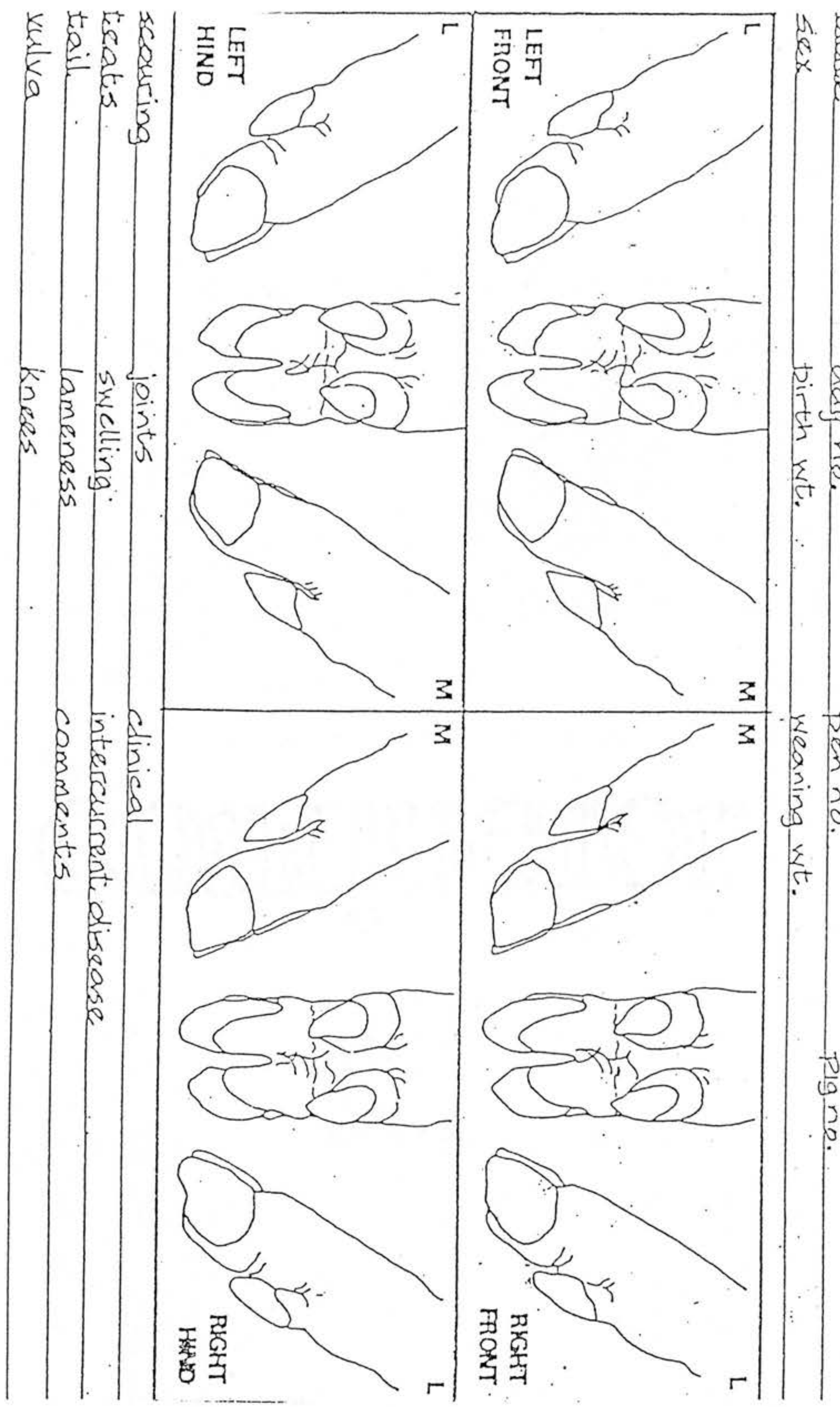
***** Estimates of regression coefficients *****

	Estimate	**s.e.**	**t**
Constant	0.597	0.106	5.61
fls	0.5510	0.0601	9.16
sd	0.00349	0.00142	2.45

flds	=	floor score
sd	=	stocking density
sscore	=	bursitis score

Regression Equation:

/Bursitis score = 0.597 + 0.551 x floor score + 0.00349 x stocking density



Appendix 5.1: **Foot scoring sheet (adapted from Smith & Mitchell 1976).**

Appendix 5.2: Analysis of variance. The effect of floor type on bursitis, knee and foot scores and daily liveweight gain

******* Analysis of variance *******

Variate : bursitis

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Litter stratum					
Floor	2	5.9052	2.9526	1.78	0.247
Residual	6	9.9441	1.6573	3.25	
Litter.pig stratum	71	36.2007	0.5099		
Total	79	52.0500			

* MESSAGE: the following units have large residuals.

litter 3	0.207	s.e. 0.332
litter 4	0.032	s.e. 0.118
litter 5	0.032	s.e. 0.042
litter 6	-0.058	s.e. 0.014
litter 7	-0.673	s.e. 0.004
litter 8	0.264	s.e. 0.002
litter 9	0.577	s.e. 0.001
litter 2 pig 4	2.050	s.e. 0.673

******* Tables of means *******

Variate : bursitis

Grand mean 0.675

Floor	A	B	C
	0.793	0.280	0.923
Rep.	29	25	26

***** Standard errors of differences of means *****

Table	floor
Rep.	unequal
s.e.d.	0.3641X min.rep
	0.3513 max-min
	0.3381X max.rep

(No comparisons in categories where s.e.d. marked with an X)

Appendix 5.2 (Contd.)

******* Analysis of variance *******

Variate : knee

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Litter stratum					
Floor	2	12.802	6.401	2.37	0.175
Residual	6	16.216	2.703	2.25	
litter.pig stratum	71	85.281	1.201		
Total	79	114.299			

* MESSAGE: the following units have large residuals.

litter 2	0.58	s.e. 0.42
litter 3	-0.42	s.e. 0.13
litter 4	0.06	s.e. 0.05
litter 5	-0.42	s.e. 0.02
litter 6	0.32	s.e. 0.01
litter 7	0.55	s.e. 0.00
litter 8	-0.81	s.e. 0.00
litter 9	0.12	s.e. 0.00

******* Tables of means *******

Variate : knee

Grand mean 2.20

Floor	A	B	C
	1.72	2.24	2.69
Rep.	29	25	26

***** Standard errors of differences of means *****

Table	Floor
Rep.	unequal
s.e.d.	0.465X min.rep
	0.449 max-min
	0.432X max.rep

(No comparisons in categories where s.e.d. marked with an X)

Appendix 5.2 (Contd.)

******* Analysis of variance *******

Variate : birthweight

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Litter stratum					
Floor	2	1.75630	0.87815	2.95	0.128
Residual	6	1.78701	0.29783	17.03	
litter.pig stratum	71	1.24157	0.01749		
Total	79	4.78487			

* MESSAGE: the following units have large residuals.

litter 3	-0.134	s.e. 0.141
litter 4	-0.040	s.e. 0.050
litter 5	-0.071	s.e. 0.018
litter 6	0.098	s.e. 0.006
litter 7	-0.167	s.e. 0.002
litter 8	-0.111	s.e. 0.001
litter 9	0.320	s.e. 0.000
litter 5 pig 1	0.325	s.e. 0.125
litter 8 pig 6	0.369	s.e. 0.125
litter 9 pig 1	0.438	s.e. 0.125

******* Tables of means *******

Variate : birthweight

Grand mean 1.551

Floor	A	B	C
	1.384	1.546	1.742
Rep.	29	25	26

***** Standard errors of differences of means *****

Table	floor
Rep.	unequal
s.e.d.	0.1544X min.rep
	0.1489 max-min
	0.1433X max.rep

(No comparisons in categories where s.e.d. marked with an X)

Appendix 5.2 (Contd.)

******* Analysis of variance *******

Variate : foot

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Litter stratum					
floor	2	62.14	31.07	1.29	0.343
Residual	6	144.79	24.13	1.93	
litter.pig stratum	71	889.87	12.53		
Total	79	1096.80			

* MESSAGE: the following units have large residuals.

litter 3	-0.48	s.e. 1.27
litter 4	-1.46	s.e. 0.45
litter 5	1.04	s.e. 0.16
litter 6	0.37	s.e. 0.05
litter 7	0.46	s.e. 0.02
litter 8	-2.91	s.e. 0.01
litter 9	2.34	s.e. 0.00
litter 6 pig 7	8.67	s.e. 3.34
litter 7 pig 1	13.00	s.e. 3.34
litter 7 pig 10	9.00	s.e. 3.34

******* Tables of means *******

Variate : foot

Grand mean 3.30

Floor	A	B	C
	2.48	2.96	4.54
Rep.	29	25	26

***** Standard errors of differences of means *****

Table	floor
Rep.	unequal
s.e.d.	1.389X min.rep
	1.341 max-min
	1.290X max.rep

(No comparisons in categories where s.e.d. marked with an X)

Appendix 5.2 (Contd.)

******* Analysis of variance *******

Variate : daily liveweight gain

Source of variation	**d.f.**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
litter stratum					
Floor	2	1033.17	516.58	6.88	0.028
Residual	6	450.44	75.07	4.76	
litter.pig stratum	71	1119.74	15.77		
Total	79	2603.35			

* MESSAGE: the following units have large residuals.

litter 2	-20.3	s.e. 22.4
litter 3	37.2	s.e. 7.1
litter 4	-5.4	s.e. 2.5
litter 5	-6.6	s.e. 0.9
litter 6	10.6	s.e. 0.3
litter 7	6.8	s.e. 0.1
litter 8	-41.0	s.e. 0.0
litter 9	32.5	s.e. 0.0
litter 3 pig 3	98.8	s.e. 37.4
litter 6 pig 3	110.0	s.e. 37.4
litter 6 pig 4	99.0	s.e. 37.4
litter 6 pig 8	-101.0	s.e. 37.4

******* Tables of means *******

Variate : daily liveweight gain

Grand mean 237.2

Floor	A	B	C
	196.0	237.4	282.8
Rep.	29	25	26

***** Standard errors of differences of means *****

Table	floor
rep.	unequal
s.e.d.	24.51X min.rep
	23.65 max-min
	22.75X max.rep

(No comparisons in categories where s.e.d. marked with an X)

Appendix 5.3: Regression analysis and correlations between bursitis, foot lesions and knee lesions.

******* Regression Analysis *******

Response variate	:	foot
Distribution	:	Poisson
Link function	:	Log
Fitted terms	:	Constant + floor

***** Summary of analysis *****

	d.f.	deviance	Mean deviance deviance	deviance ratio
Regression	2	18.1	9.069	2.41
Residual	77	289.7	3.763	
Total	79	307.9	3.897	
Change	-2	-18.1	9.069	2.41

* MESSAGE: The following units have large standardized residuals:
55 2.50

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	0.909	0.228	3.98
Floor B	0.176	0.321	0.55
Floor C	0.603	0.290	2.08

* MESSAGE: Term litter cannot be fully included in the model
because 2 parameters are aliased with terms already in the model

******* Regression Analysis *******

Response variate	:	foot
Distribution	:	Poisson
Link function	:	Log
Fitted terms	:	Constant + floor + litter

Appendix 5.3: (Contd.)

***** Summary of analysis *****

	d.f.	deviance	Mean deviance	deviance ratio
Regression	8	58.6	7.322	2.09
Residual	71	249.3	3.511	
Total	79	307.9	3.897	
Change	-6	-40.4	6.740	1.92

* MESSAGE: The following units have large standardized residuals:
55 2.52

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	0.938	0.390	2.40
Floor B	0.266	0.519	0.51
Floor C	0.990	0.465	2.13
Litter 2	0.126	0.523	0.24
Litter 3	-0.245	0.572	-0.43
Litter 4	-0.799	0.639	-1.25
Litter 5	0.182	0.476	0.38
Litter 6	0	*	*
Litter 7	-0.318	0.365	-0.87
Litter 8	-1.442	0.578	-2.50
Litter 9	0	*	*

* MESSAGE: Term litter cannot be fully included in the model
because 2 parameters are aliased with terms already in the model

******* Regression Analysis *******

Response variate	:	foot
Distribution	:	Poisson
Link function	:	Log
Fitted terms	:	Constant + floor + litter + dlwg

Appendix 5.3: (Contd.)

***** Summary of analysis *****

	d.f.	deviance	Mean deviance	deviance ratio
Regression	9	66.8	7.418	2.15
Residual	70	241.1	3.444	
Total	79	307.9	3.897	
Change	-1	-8.2	8.188	2.38

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	0.119	0.662	0.18
Floor B	-0.107	0.582	-0.18
Floor C	0.361	0.614	0.59
Litter 2	0.135	0.517	0.26
Litter 3	-0.505	0.592	-0.85
Litter 4	0.667	0.645	-1.03
Litter 5	0.309	0.485	0.64
Litter 6	0	*	*
Litter 7	-0.206	0.369	-0.56
Litter 8	-1.106	0.613	-1.81
Litter 9	0	*	*
dlwg	0.00457	0.00296	1.54

Appendix 5.3: (Contd.)

***** Correlations *****

Estimate	Ref	Correlations						
Constant	1	1.000						
Floor B	2	-0.003	1.000					
Floor C	3	0.172	0.729	1.000				
Litter 2	4	-0.445	0.488	0.460	1.000			
Litter 3	5	-0.142	0.570	0.603	0.482	1.000		
Litter 4	6	-0.156	-0.396	-0.127	0.002	-0.056	1.000	
Litter 5	7	-0.189	-0.516	-0.154	0.003	-0.068	0.412	1.000
Litter 6	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Litter 7	9	-0.152	-0.088	-0.401	0.002	-0.055	0.036	0.043
Litter 8	10	-0.290	-0.168	-0.403	0.005	-0.104	0.068	0.083
Litter 9	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
dlwg	12	-0.813	-0.472	-0.662	0.013	-0.292	0.192	0.232
		1	2	3	4	5	6	7

Litter 6	8	0.000				
Litter 7	9	0.000	1.000			
Litter 8	10	0.000	0.344	1.000		
Litter 9	11	0.000	0.000	0.000	0.000	
dlwg	12	0.000	0.187	0.357	0.000	1.000
		8	9	10	11	12

***** Accumulated analysis of deviance *****

Change	d.f.	deviance	Mean deviance	deviance ratio
+ floor	2	18.137	9.069	2.63
+ litter	6	40.439	6.740	1.96
+ dlwg	1	8.188	8.188	2.38
Residual	70	241.092	3.444	
Total	79	307.856	3.897	

***** Predictions from regression model *****

Table contains predictions followed by standard errors

Response variate : foot

Floor

A	2.881	1.065
B	2.588	0.809
C	4.133	1.400

* Standard errors are approximate, since model is not linear

Appendix 5.3: (Contd.)

***** Degrees of freedom *****

Sums of squares	:	79
Sums of products	:	78
Correlations	:	78

***** Sums of squares and products *****

Bursitis	1	52.05		
Knee	2	3.58	114.30	
Foot	3	34.30	115.56	1096.80
		1	2	3

***** Means *****

Bursitis	1	0.6750
Knee	2	2.197
Foot	3	3.300

***** Number of units used *****

80

***** Correlation matrix *****

Bursitis	1	1.000		
Knee	2	0.046	1.000	
Foot	3	0.144	0.326	1.000
		1	2	3

***** Degrees of freedom *****

Sums of squares	:	71
Sums of products	:	70
Correlations	:	70

***** Sums of squares and products *****

Bursitis	1	36.20		
Knee	2	6.90	85.28	
Foot	3	25.15	63.89	889.87
		1	2	3

Appendix 5.3: (Contd.)

***** Means over all groups *****

Bursitis	1	0.6750
Knee	2	2.197
Foot	3	3.300

***** Number of units used *****

80

***** Correlation matrix *****

Bursitis	1	1.000		
Knee	2	0.124	1.000	
Foot	3	0.140	0.232	1.000
		1	2	3

Appendix 5.4: Effect of farm on bursitis over time

Farm	Week	Bursitis	Total
1	3.00	2.00	41.00
1	5.00	7.00	41.00
1	8.00	16.00	41.00
1	12.00	33.00	41.00
1	22.00	39.00	41.00
2	3.00	30.00	48.00
2	7.00	35.00	48.00
2	11.00	45.00	48.00
2	20.00	47.00	48.00
3	3.00	21.00	34.00
3	8.00	23.00	34.00
3	13.00	33.50	34.00
4	4.00	8.00	59.00
4	11.00	36.00	58.00
4	14.00	46.00	57.00
4	25.00	45.00	50.00

```
7 calc p=burs/tot
8   & lp=log(p/(1-p))
9 graph p;week;sym=farm
```

******* Regression Analysis *******

Response variate	:	bursitis
Binomial totals	:	total
Distribution	:	Binomial
Link function	:	Logit
Fitted terms	:	Constant + week

***** Summary of analysis *****

Dispersion parameter is 1

	d.f.	deviance	Mean deviance	deviance ratio
Regression	1	185.5	185.507	19.54
Residual	14	132.9	9.492	
Total	15	318.4	21.226	
Change	-1	-185.5	185.507	19.54

Appendix 5.4 (Contd.)

* MESSAGE: The following units have large standardized residuals:

1	-4.81
2	-3.73
3	-2.60
6	4.64
7	2.95
8	3.99
10	3.69
12	3.52
13	-4.59
16	-3.13

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	-1.348	0.179	-7.53
Week	0.2110	0.0195	10.84

* MESSAGE: s.e.s are based on dispersion parameter with value 1

14 add farm

******* Regression Analysis *******

Response variate	:	bursitis
Binomial totals	:	total
Distribution	:	Binomial
Link function	:	Logit
Fitted terms	:	Constant + week + farm

***** Summary of analysis *****

Dispersion parameter is 1

	d.f.	deviance	Mean deviance	deviance ratio
Regression	4	288.36	72.090	26.40
Residual	11	30.03	2.730	
Total	15	318.39	21.226	
Change	-3	-102.85	34.285	12.56

Appendix 5.4 (Contd.)

* MESSAGE: The following units have large standardized residuals:

1	-2.33
4	2.82
11	-2.24
16	-3.18

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	-2.534	0.262	-9.68
Week	0.2602	0.0234	11.13
Farm 2	2.047	0.275	7.45
Farm 3	1.885	0.312	6.05
Farm 4	-0.043	0.249	-0.17

* MESSAGE: s.e.s are based on dispersion parameter with value 1
15 add [prin=a,s,c,e]week.farm

******* Regression Analysis *******

***** Summary of analysis *****

Dispersion parameter is 1

	d.f.	deviance	Mean deviance	deviance ratio
Regression	7	294.61	42.087	14.15
Residual	8	23.79	2.973	
Total	15	318.39	21.226	
Change	-3	-6.25	2.082	0.70

* MESSAGE: The following units have large standardized residuals:

5	-2.06
10	2.33
11	-2.18
12	2.78
13	-3.18
15	2.06
16	-2.84

Appendix 5.4 (Contd.)

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	-3.370	0.474	-7.10
Week	0.3620	0.0535	6.77
Farm 2	3.129	0.610	5.13
Farm 3	2.916	0.681	4.28
Farm 4	1.177	0.616	1.91
Week.farm 2	-0.1423	0.0749	-1.90
Week.farm 3	-0.1340	0.0868	-1.54
Week.farm 4	-0.1380	0.0631	-2.19

* MESSAGE: s.e.s are based on dispersion parameter with value 1

***** Correlations *****

Estimate	Ref	Correlations						
Constant	1	1.000						
Week	2	-0.916	1.000					
Farm 2	3	-0.777	0.712	1.000				
Farm 3	4	-0.697	0.638	0.542	1.000			
Farm 4	5	-0.771	0.706	0.599	0.537	1.000		
Week.farm 2	6	0.654	-0.714	-0.884	-0.456	-0.504	1.000	
Week.farm 3	7	0.564	-0.616	-0.439	-0.880	-0.435	0.440	1.000
Week.farm 4	8	0.776	-0.847	-0.604	-0.541	-0.906	0.605	0.522
		1	2	3	4	5	6	7
Week.farm 4		8	1.000					
		8						

***** Accumulated analysis of deviance *****

Change	d.f.	deviance	Mean deviance	deviance ratio
+ week	1	185.507	185.507	62.39
+ farm	3	102.854	34.285	11.53
+ week.farm	3	6.247	2.082	0.70
Residual	8	23.786	2.973	
Total	15	318.394	21.226	

Appendix 6.1: The ear number, sex, bursitis score (Left and Right) and mean bursitis score - Trial 1.

Ear No.	Sex	Bursitis score Left	Right	Mean	Ear No.	Sex	Bursitis score Left	Right	Mean
4825	F	0	0	0.00	4825	F	0	0	0.00
4826	F	2	1	1.50	4826	F	2	1	1.50
4854	F	2	2	2.00	4854	F	2	1	1.50
4872	F	2	2	2.00	4872	F	2	2	2.00
4920	F	1	2	1.50	4920	F	1	1	1.00
4922	F	2	2	2.00	4922	F	1	1	1.00
4923	M	1	0	0.50	4923	M	1	0	0.50
4953	M	0	2	1.00	4953	M	0	2	1.00
4954	F	2	3	2.50	4954	F	2	2	2.00
4956	M	1	0	0.50	4956	M	0	0	0.00
4958	F	2	1	1.50	4958	F	1	0	0.50
4966	M	0	1	0.50	4966	M	0	1	0.50
4972	M	1	2	1.50	4972	M	0	1	0.50
4975	F	2	2	2.00	4975	F	2	2	2.00
4976	M	3	2	2.50	4976	M	3	2	2.50
4978	M	1	1	1.00	4978	M	1	1	1.00
4979	M	1	2	1.50	4979	M	1	1	1.00
4981	F	2	3	2.50	4981	F	2	2	2.00
4986	F	2	2	2.00	4986	F	2	2	2.00
4990	M	1	0	0.50	4990	M	1	0	0.50
4992	M	0	1	0.50	4992	M	0	0	0.00
4998	M	1	1	1.00	4998	M	1	1	1.00
5001	M	1	1	1.00	5001	M	1	1	1.00
5002	M	0	0	0.00	5002	M	0	0	0.00
5014	M	1	1	1.00	5014	M	0	1	0.50
5024	F	1	1	1.00	5024	F	1	0	0.50
5027	M	1	1	1.00	5027	M	1	1	1.00
5028	M	0	1	0.50	5028	M	0	0	0.00
5040	F	1	0	0.50	5040	F	0	0	0.00
5048	F	2	1	1.50	5048	F	1	1	1.00
4825	F	0	0	0.00	4825	F	0	0	0.00
4826	F	2	1	1.50	4826	F	2	1	1.50
4854	F	2	1	1.50	4854	F	2	1	1.50
4872	F	1	1	1.00	4872	F	1	1	1.00
4920	F	1	1	1.00	4920	F	1	1	1.00
4922	F	1	1	1.00	4922	F	1	1	1.00
4923	M	1	0	0.50	4923	M	1	0	0.50
4953	M	0	2	1.00	4953	M	0	1	0.50
4954	F	2	2	2.00	4954	F	2	2	2.00
4956	M	0	0	0.00	4956	M	0	0	0.00
4958	F	1	0	0.50	4958	F	0	0	0.00
4966	M	0	0	0.00	4966	M	0	0	0.00
4972	M	0	1	0.50	4972	M	0	1	0.50
4975	F	1	1	1.00	4975	F	0	1	0.50
4976	M	2	1	1.50	4976	M	2	1	1.50
4978	M	1	1	1.00	4978	M	1	0	0.50

Appendix 6.1(Contd.)

Ear No.	Sex	Bursitis score Left	Right	Mean	Ear No.	Sex	Bursitis score Left	Right	Mean
4979	M	1	1	1.00	4979	M	1	1	1.00
4981	F	2	2	2.00	4981	F	2	2	2.00
4986	F	2	2	2.00	4986	F	2	2	2.00
4990	M	1	0	0.50	4990	M	0	0	0.00
4992	M	0	0	0.00	4992	M	0	0	0.00
4998	M	1	1	1.00	4998	M	1	0	0.50
5001	M	1	1	1.00	5001	M	1	0	0.50
5002	M	0	0	0.00	5002	M	0	0	0.00
5014	M	0	1	0.50	5014	M	0	1	0.50
5024	F	1	0	0.50	5024	F	1	0	0.50
5027	M	1	1	1.00	5027	M	1	1	1.00
5028	M	0	0	0.00	5028	M	0	0	0.00
5040	F	0	0	0.00	5040	F	0	0	0.00
5048	F	1	1	1.00	5048	F	1	1	1.00
4825	F	0	0	0.00	4825	F	0	0	0.00
4826	F	2	1	1.50	4826	F	2	1	1.50
4854	F	2	1	1.50	4854	F	1	1	1.00
4872	F	1	1	1.00	4872	F	0	0	0.00
4920	F	1	1	1.00	4920	F	1	1	1.00
4922	F	1	1	1.00	4922	F	1	0	0.50
4923	M	0	0	0.00	4923	M	0	0	0.00
4953	M	0	1	0.50	4953	M	0	1	0.50
4954	F	2	2	2.00	4954	F	2	2	2.00
4956	M	0	0	0.00	4956	M	0	0	0.00
4958	F	0	0	0.00	4958	F	0	0	0.00
4966	M	0	0	0.00	4966	M	0	0	0.00
4972	M	0	1	0.50	4972	M	0	1	0.50
4975	F	0	1	0.50	4975	F	0	0	0.00
4976	M	2	1	1.50	4976	M	1	1	1.00
4978	M	1	0	0.50	4978	M	0	0	0.00
4979	M	1	1	1.00	4979	M	1	1	1.00
4981	F	2	2	2.00	4981	F	1	2	1.50
4986	F	2	2	2.00	4986	F	2	2	2.00
4990	M	0	0	0.00	4990	M	0	0	0.00
4992	M	0	0	0.00	4992	M	0	0	0.00
4998	M	1	0	0.50	4998	M	1	0	0.50
5001	M	1	0	0.50	5001	M	1	0	0.50
5002	M	0	0	0.00	5002	M	0	0	0.00
5014	M	0	1	0.50	5014	M	0	1	0.50
5024	F	1	0	0.50	5024	F	1	0	0.50
5027	M	1	1	1.00	5027	M	1	1	1.00
5028	M	0	0	0.00	5028	M	0	0	0.00
5040	F	0	0	0.00	5040	F	0	0	0.00
5048	F	0	0	0.00	5048	F	0	0	0.00

Appendix 6.1 Trial 1(Contd.)

Decrease in prevalence of bursitis

nb[1]	pcnr[1]	
28	0.00	

nb[2]	pcnr[2]	
24	14.29	

nb[3]	pcnr[3]	
23	4.17	

nb[4]	pcnr[4]	
21	8.70	

nb[5]	pcnr[5]	
19	9.52	

nb[6]	pcnr[6]	pcnro
16	15.79	42.86

nb = No. of animals with bursitis in period

pcnr = Percentage of animals recovered in each period (as a proportion of those with bursitis at the start of the period)

pcnro = Overall proportion (%) of animals recovered during whole trial

Decrease in severity of bursitis

ms[2]	vs[2]	ses[2]
0.300	0.114	0.062

ms[3]	vs[3]	ses[3]
0.117	0.098	0.057

ms[4]	vs[4]	ses[4]
0.117	0.046	0.039

ms[5]	vs[5]	ses[5]
0.050	0.041	0.037

ms[6]	vs[6]	ses[6]
0.133	0.068	0.048

ms[7]	vs[7]	ses[7]
0.717	0.322	0.104

ms = mean change in score for each period

ms[2] = mean change in score for period 1 to period 2

ses = standard error associated with each of mean changes of score

Appendix 6.1: The ear number sex bursitis score (left and right) and mean bursitis score - Trial 2

Ear No.	Sex	Bursitis score Left	Right	Mean	Ear No.	Sex	Bursitis score Left	Right	Mean
6167	M	0	2	1.00	6167	M	0	2	1.00
6214	F	2	2	2.00	6214	F	2	2	2.00
6249	F	1	1	1.00	6249	F	1	1	1.00
6252	F	1	1	1.00	6252	F	0	1	0.50
6254	F	0	0	0.00	6254	F	0	0	0.00
6255	F	1	2	1.50	6255	F	1	2	1.50
6256	M	1	1	1.00	6256	M	0	0	0.00
6257	F	0	0	0.00	6257	F	0	0	0.00
6259	M	0	0	0.00	6259	M	0	0	0.00
6278	F	1	1	1.00	6278	F	1	1	1.00
6290	F	1	0	0.50	6290	F	0	0	0.00
6303	M	0	0	0.00	6303	M	0	0	0.00
6305	M	0	0	0.00	6305	M	0	0	0.00
6309	F	0	0	0.00	6309	F	0	0	0.00
6316	M	2	2	2.00	6316	M	2	2	2.00
6335	M	0	0	0.00	6335	M	0	0	0.00
6354	F	1	1	1.00	6354	F	0	0	0.00
6355	M	0	0	0.00	6355	M	0	0	0.00
6371	M	1	1	1.00	6371	M	0	0	0.00
6376	F	2	2	2.00	6376	F	1	1	1.00
6378	M	2	2	2.00	6378	M	1	1	1.00
6381	M	2	1	1.50	6381	M	1	0	0.50
6392	F	1	1	1.00	6392	F	1	1	1.00
6394	M	0	1	0.50	6394	M	0	1	0.50
6397	F	2	1	1.50	6397	F	1	1	1.00
6398	M	2	1	1.50	6398	M	1	1	1.00
6401	F	2	2	2.00	6401	F	2	2	2.00
6404	M	0	0	0.00	6404	M	0	0	0.00
6408	F	0	0	0.00	6408	F	0	0	0.00
6410	M	0	2	1.00	6410	M	0	2	1.00
6167	M	0	0	0.00	6167	M	0	0	0.00
6214	F	1	1	1.00	6214	F	1	1	1.00
6249	F	1	0	0.50	6249	F	1	0	0.50
6252	F	0	0	0.00	6252	F	0	0	0.00
6254	F	0	0	0.00	6254	F	0	0	0.00
6255	F	1	1	1.00	6255	F	0	0	0.00
6256	M	0	0	0.00	6256	M	0	0	0.00
6257	F	0	0	0.00	6257	F	0	0	0.00
6259	M	0	0	0.00	6259	M	0	0	0.00
6278	F	0	0	0.00	6278	F	0	0	0.00
6290	F	0	0	0.00	6290	F	0	0	0.00
6303	M	0	0	0.00	6303	M	0	0	0.00
6305	M	0	0	0.00	6305	M	0	0	0.00
6309	F	0	0	0.00	6309	F	0	0	0.00
6316	M	2	2	2.00	6316	M	2	2	2.00
6335	M	0	0	0.00	6335	M	0	0	0.00

Appendix 6.1(Contd.)

Ear No.	Sex	Bursitis score Left	Right	Mean	Ear No.	Sex	Bursitis score Left	Right	Mean
6354	F	0	0	0.00	6354	F	0	0	0.00
6355	M	0	0	0.00	6355	M	0	0	0.00
6371	M	0	0	0.00	6371	M	0	0	0.00
6376	F	1	1	1.00	6376	F	1	1	1.00
6378	M	1	1	1.00	6378	M	1	1	1.00
6381	M	0	0	0.00	6381	M	0	0	0.00
6392	F	0	0	0.00	6392	F	0	0	0.00
6394	M	0	1	0.50	6394	M	0	1	0.50
6397	F	1	0	0.50	6397	F	0	0	0.00
6398	M	1	1	1.00	6398	M	0	0	0.00
6401	F	1	1	1.00	6401	F	1	1	1.00
6404	M	0	0	0.00	6404	M	0	0	0.00
6408	F	0	0	0.00	6408	F	0	0	0.00
6410	M	0	1	0.50	6410	M	0	1	0.50
6167	M	0	0	0.00	6167	M	0	0	0.00
6214	F	1	1	1.00	6214	F	1	1	1.00
6249	F	1	0	0.50	6249	F	1	0	0.50
6252	F	0	0	0.00	6252	F	0	0	0.00
6254	F	0	0	0.00	6254	F	0	0	0.00
6255	F	0	0	0.00	6255	F	0	0	0.00
6256	M	0	0	0.00	6256	M	0	0	0.00
6257	F	0	0	0.00	6257	F	0	0	0.00
6259	M	0	0	0.00	6259	M	0	0	0.00
6278	F	0	0	0.00	6278	F	0	0	0.00
6290	F	0	0	0.00	6290	F	0	0	0.00
6303	M	0	0	0.00	6303	M	0	0	0.00
6305	M	0	0	0.00	6305	M	0	0	0.00
6309	F	0	0	0.00	6309	F	0	0	0.00
6316	M	2	2	2.00	6316	M	2	2	2.00
6335	M	0	0	0.00	6335	M	0	0	0.00
6354	F	0	0	0.00	6354	F	0	0	0.00
6355	M	0	0	0.00	6355	M	0	0	0.00
6371	M	0	0	0.00	6371	M	0	0	0.00
6376	F	1	1	1.00	6376	F	1	1	1.00
6378	M	1	1	1.00	6378	M	1	1	1.00
6381	M	0	0	0.00	6381	M	0	0	0.00
6392	F	0	0	0.00	6392	F	0	0	0.00
6394	M	0	1	0.50	6394	M	0	0	0.00
6397	F	0	0	0.00	6397	F	0	0	0.00
6398	M	0	0	0.00	6398	M	0	0	0.00
6401	F	1	1	1.00	6401	F	0	1	0.50
6404	M	0	0	0.00	6404	M	0	0	0.00
6408	F	0	0	0.00	6408	F	0	0	0.00
6410	M	0	1	0.50	6410	M	0	0	0.00

Appendix 6.1 Trial 2(Contd.)

Decrease in prevalence of bursitis

nb[1]	pcnr[1]	
20	0.00	
nb[2]	pcnr[2]	
16	20.00	
nb[3]	pcnr[3]	
11	31.25	
nb[4]	pcnr[4]	
8	27.27	
nb[5]	pcnr[5]	
8	0.00	
nb[6]	pcnr[6]	pcnro
6	25.00	70.00

nb = No. of animals with bursitis in period

pcnr = Percentage of animals recovered in each period (as a proportion of those with bursitis at the start of the period).e.g.

4 animals recovered in period 1
4/20 * 100 = 20%

pcnro = Overall (proportion (%) of animals recovered during whole trial).

Decrease in severity of bursitis

ms[2]	vs[2]	ses[2]
0.267	0.168	0.075
ms[3]	vs[3]	ses[3]
0.267	0.151	0.071
ms[4]	vs[4]	ses[4]
0.083	0.070	0.048
ms[5]	vs[5]	ses[5]
0.000	0.000	0.000
ms[6]	vs[6]	ses[6]
0.050	0.023	0.028
ms[7]	vs[7]	ses[7]
0.667	0.333	0.105

ms = mean change in score for each period

ms[2] = mean change in score for period 1 to period 2.

ses = standard error associated with each of mean changes of score.

Appendix 6.1: The ear number, sex, bursitis score (left and right) and mean bursitis score - Trial 3

Ear No.	Sex	Bursitis score Left	Right	Mean	Ear No.	Sex	Bursitis score Left	Right	Mean
7986	M	1	1	1.00	7986	M	0	0	0.00
8109	F	1	1	1.00	8109	F	1	1	1.00
8116	M	1	1	1.00	8116	M	0	0	0.00
8117	M	3	3	3.00	8117	M	2	2	2.00
8119	F	3	2	2.50	8119	F	0	1	0.50
8122	M	0	0	0.00	8122	M	0	0	0.00
8123	M	3	3	3.00	8123	M	0	0	0.00
8124	M	0	1	0.50	8124	M	0	0	0.00
8127	F	2	3	2.50	8127	F	1	2	1.50
8129	M	2	3	2.50	8129	M	1	1	1.00
8130	F	1	0	0.50	8130	F	0	0	0.00
8134	M	2	1	1.50	8134	M	1	1	1.00
8135	F	0	0	0.00	8135	F	0	0	0.00
8136	M	2	1	1.50	8136	M	1	1	1.00
8138	M	2	1	1.50	8138	M	0	0	0.00
8147	F	1	1	1.00	8147	F	1	0	0.50
8153	M	2	2	2.00	8153	M	2	1	1.50
8156	M	2	1	1.50	8156	M	1	0	0.50
8157	F	1	2	1.50	8157	F	1	2	1.50
8161	M	0	1	0.50	8161	M	0	1	0.50
8162	M	2	1	1.50	8162	M	1	1	1.00
8164	F	1	2	1.50	8164	F	1	1	1.00
8169	M	2	1	1.50	8169	M	1	1	1.00
8170	F	3	3	3.00	8170	F	2	2	2.00
8173	F	2	2	2.00	8173	F	1	1	1.00
8175	M	1	1	1.00	8175	M	0	0	0.00
8181	M	3	3	3.00	8181	M	1	1	1.00
8182	F	1	1	1.00	8182	F	1	0	0.50
8199	F	2	1	1.50	8199	F	1	1	1.00
7986	M	0	0	0.00	7986	M	0	0	0.00
8109	F	0	1	0.50	8109	F	0	0	0.00
8116	M	0	0	0.00	8116	M	0	0	0.00
8117	M	2	2	2.00	8117	M	2	2	2.00
8119	F	0	1	0.50	8119	F	0	0	0.00
8122	M	0	0	0.00	8122	M	0	0	0.00
8123	M	0	0	0.00	8123	M	0	0	0.00
8124	M	0	0	0.00	8124	M	0	0	0.00
8127	F	1	2	1.50	8127	F	1	1	1.00
8129	M	1	0	0.50	8129	M	0	0	0.00
8130	F	0	0	0.00	8130	F	0	0	0.00
8134	M	1	1	1.00	8134	M	0	1	0.50
8135	F	0	0	0.00	8135	F	0	0	0.00
8136	M	0	0	0.00	8136	M	0	0	0.00
8138	M	0	0	0.00	8138	M	0	0	0.00
8147	F	1	0	0.50	8147	F	1	0	0.50
8153	M	1	0	0.50	8153	M	1	0	0.50

Appendix 6.1 (Contd.)

Ear No.	Sex	Bursitis score Left	Right	Mean	Ear No.	Sex	Bursitis score Left	Right	Mean
8156	M	1	1	1.00	8156	M	1	0	0.50
8157	F	0	1	0.50	8157	F	0	1	0.50
8161	M	0	0	0.00	8161	M	0	0	0.00
8162	M	1	1	1.00	8162	M	1	1	1.00
8164	F	1	1	1.00	8164	F	0	0	0.00
8169	M	1	0	0.50	8169	M	1	0	0.50
8170	F	1	1	1.00	8170	F	1	0	0.50
8173	F	1	0	0.50	8173	F	1	0	0.50
8175	M	0	0	0.00	8175	M	0	0	0.00
8181	M	0	0	0.00	8181	M	0	0	0.00
8182	F	0	0	0.00	8182	F	0	0	0.00
8199	F	0	0	0.00	8199	F	0	0	0.00
7986	M	0	0	0.00	8153	M	1	0	0.50
8109	F	0	0	0.00	8156	M	1	0	0.50
8116	M	0	0	0.00	8157	F	0	0	0.00
8117	M	2	2	2.00	8161	M	0	0	0.00
8119	F	0	0	0.00	8162	M	1	1	1.00
8122	M	0	0	0.00	8164	F	0	0	0.00
8123	M	0	0	0.00	8169	M	1	0	0.50
8124	M	0	0	0.00	8170	F	0	0	0.00
8127	F	0	1	0.50	8173	F	0	0	0.00
8129	M	0	0	0.00	8175	M	0	0	0.00
8130	F	0	0	0.00	8181	M	0	0	0.00
8134	M	0	0	0.00	8182	F	0	0	0.00
8135	F	0	0	0.00	8199	F	0	0	0.00
8138	M	0	0	0.00	8136	M	0	0	0.00
8147	F	1	0	0.50					

Appendix 6.1 Trial 3(Contd.)

Decrease in prevalence of bursitis

nb[1]	pcnr[1]	
27	0.00	
nb[2]	pcnr[2]	
20	25.93	
nb[3]	pcnr[3]	
15	25.00	
nb[4]	pcnr[4]	
11	26.67	
nb[5]	pcnr[5]	pcnro
7	36.36	74.07

nb = No. of animals with bursitis

pcnr = Percentage of animals recovered in each period (as a proportion of those with bursitis at the start of the period).

pcnro = Overall proportion (%) of animals recovered during whole trial.

Decrease in severity of bursitis

ms[2]	vs[2]	ses[2]
0.810	0.472	0.128
ms[3]	vs[3]	ses[3]
0.293	0.188	0.080
ms[4]	vs[4]	ses[4]
0.155	0.073	0.050
ms[5]	vs[5]	ses[5]
0.086	0.037	0.036
ms[6]	vs[6]	ses[6]
1.345	0.716	0.157

ms = mean change in score for each period

ms[2] = mean change in score for period 1 to period 2

ses = standard error associated with each of mean changes of score.

Appendix 6.2: The examination number,ear number, pen number and bursitis score for left/right leg.

Ear No.	Pen	Bursitis score Left	Right	Mean	Ear No.	Pen	Bursitis score Left	Right	Mean
Examination No.1					**Examination No. 2**				
1	5	1	1	1.00	1	5	0	1	0.50
2	2	0	0	0.00	2	2	1	1	1.00
4	4	0	0	0.00	4	4	0	0	0.00
6	2	1	1	1.00	6	2	1	1	1.00
7	3	1	1	1.00	7	3	1	1	1.00
8	1	0	0	0.00	8	1	0	0	0.00
9	4	0	0	0.00	9	4	0	0	0.00
10	1	1	0	0.50	10	1	0	0	0.00
11	2	0	0	0.00	11	2	0	0	0.00
12	1	2	1	1.50	12	1	2	1	1.50
15	4	2	1	1.50	15	4	1	1	1.00
16	1	0	0	0.00	16	1	1	1	1.00
18	1	0	0	0.00	18	1	0	0	0.00
19	2	2	2	2.00	19	2	2	1	1.50
20	3	1	1	1.00	20	3	1	1	1.00
21	4	1	2	1.50	21	4	0	1	0.50
23	5	1	1	1.00	23	5	1	1	1.00
24	1	0	0	0.00	24	1	1	0	0.50
25	5	2	2	2.00	25	5	2	3	2.50
26	1	1	1	1.00	26	1	1	0	0.50
27	1	2	1	1.50	27	1	1	1	1.00
30	4	2	1	1.50	30	4	1	0	0.50
31	1	1	1	1.00	31	1	0	1	0.50
33	4	0	1	0.50	33	4	0	0	0.00
34	4	0	0	0.00	34	4	0	0	0.00
35	1	2	1	1.50	35	1	2	2	2.00
37	3	0	0	0.00	37	3	1	1	1.00
38	4	2	2	2.00	38	4	0	0	0.00
39	1	2	1	1.50	39	1	3	2	2.50
41	3	1	1	1.00	41	3	1	2	1.50
42	4	2	0	1.00	42	4	1	2	1.50
43	5	0	1	0.50	43	5	1	1	1.00
45	1	2	2	2.00	45	1	1	1	1.00
46	3	2	2	2.00	46	3	2	2	2.00
47	3	0	1	0.50	47	3	0	2	1.00
48	4	1	2	1.50	48	4	1	1	1.00
49	2	0	0	0.00	49	2	0	0	0.00
50	5	1	2	1.50	50	5	1	2	1.50
51	5	1	1	1.00	51	5	1	1	1.00
53	2	1	2	1.50	53	2	1	3	2.00
55	2	2	2	2.00	55	2	2	2	2.00
56	2	2	1	1.50	56	2	2	2	2.00
57	2	1	1	1.00	57	2	2	2	2.00
58	5	1	0	0.50	58	5	1	1	1.00
59	3	0	1	0.50	59	3	0	2	1.00

Appendix 6.2 (Contd.)

Ear No.	Pen	Bursitis score Left	Right	Mean	Ear No.	Pen	Bursitis score Left	Right	Mean
Examination No.1					**Examination No. 2**				
60	5	3	2	2.50	60	5	2	2	2.00
61	1	0	0	0.00	61	1	0	1	0.50
62	2	0	0	0.00	62	2	0	0	0.00
63	3	0	0	0.00	63	3	0	1	0.50
64	4	0	0	0.00	64	4	0	0	0.00
67	3	0	1	0.50	67	3	0	1	0.50
70	4	1	1	1.00	70	4	0	0	0.00
71	5	0	0	0.00	71	5	0	0	0.00
73	2	1	1	1.00	73	2	1	1	1.00
74	3	0	0	0.00	74	3	0	0	0.00
75	4	2	3	2.50	75	4	2	2	2.00
76	1	1	1	1.00	76	1	0	0	0.00
77	2	1	1	1.00	77	2	1	0	0.50
78	3	1	1	1.00	78	3	1	1	1.00
79	4	0	0	0.00	79	4	0	1	0.50
80	5	2	2	2.00	80	5	0	0	0.00
81	1	1	1	1.00	81	1	2	2	2.00
82	2	1	1	1.00	82	2	1	1	1.00
83	3	0	0	0.00	83	3	1	1	1.00
84	4	1	1	1.00	84	4	1	1	1.00
85	2	0	0	0.00	85	2	1	1	1.00
88	3	0	0	0.00	88	3	0	0	0.00
89	2	2	2	2.00	89	2	2	2	2.00
90	3	0	0	0.00	90	3	0	1	0.50
91	5	1	1	1.00	91	5	1	2	1.50
93	5	0	0	0.00	93	5	0	1	0.50
97	5	2	2	2.00	97	5	0	0	0.00
98	5	0	0	0.00	98	5	2	2	2.00
99	5	0	0	0.00	99	5	0	0	0.00
Examination No. 3					**Examination No.4**				
1	5	1	1	1.00	1	5	1	1	1.00
2	2	1	1	1.00	2	2	1	1	1.00
4	4	0	0	0.00	4	4	0	0	0.00
6	2	1	1	1.00	6	2	1	1	1.00
7	3	1	2	1.50	7	3	1	1	1.00
8	1	0	1	0.50	8	1	0	0	0.00
9	4	0	0	0.00	9	4	0	0	0.00
10	1	1	0	0.50	10	1	1	0	0.50
11	2	0	0	0.00	11	2	0	0	0.00
12	1	2	2	2.00	12	1	2	1	1.50
15	4	1	1	1.00	15	4	1	1	1.00
16	1	1	1	1.00	16	1	1	1	1.00
18	1	0	0	0.00	18	1	1	0	0.50
19	2	1	1	1.00	19	2	1	1	1.00

Appendix 6.2 (Contd.)

Ear No.	Pen	Bursitis score Left	Right	Mean	Ear No.	Pen	Bursitis score Left	Right	Mean
Examination No. 3					**Examination No.4**				
20	3	1	1	1.00	20	3	1	1	1.00
21	4	0	0	0.00	21	4	0	0	0.00
23	5	0	1	0.50	23	5	1	1	1.00
24	1	1	1	1.00	24	1	1	1	1.00
25	5	2	2	2.00	25	5	1	1	1.00
26	1	1	2	1.50	26	1	1	1	1.00
27	1	2	2	2.00	27	1	2	2	2.00
30	4	1	1	1.00	30	4	1	1	1.00
31	1	1	2	1.50	31	1	1	1	1.00
33	4	0	0	0.00	33	4	0	0	0.00
34	4	0	0	0.00	34	4	0	0	0.00
35	1	2	3	2.50	35	1	1	2	1.50
37	3	1	1	1.00	37	3	1	1	1.00
38	4	0	0	0.00	38	4	0	0	0.00
39	1	3	3	3.00	39	1	1	0	0.50
41	3	2	2	2.00	41	3	2	2	2.00
42	4	0	1	0.50	42	4	0	1	0.50
43	5	1	1	1.00	43	5	1	0	0.50
45	1	1	1	1.00	45	1	1	1	1.00
46	3	2	2	2.00	46	3	1	1	1.00
47	3	0	2	1.00	47	3	1	1	1.00
48	4	0	0	0.00	48	4	0	0	0.00
49	2	0	0	0.00	49	2	0	0	0.00
50	5	1	1	1.00	50	5	1	2	1.50
51	5	1	1	1.00	51	5	1	1	1.00
53	2	1	3	2.00	53	2	1	3	2.00
55	2	3	3	3.00	55	2	2	2	2.00
56	2	3	3	3.00	56	2	2	3	2.50
57	2	2	3	2.50	57	2	2	2	2.00
58	5	2	1	1.50	58	5	2	3	2.50
59	3	1	2	1.50	59	3	2	3	2.50
60	5	2	2	2.00	60	5	2	2	2.00
61	1	1	1	1.00	61	1	0	0	0.00
62	2	0	0	0.00	62	2	0	0	0.00
63	3	1	1	1.00	63	3	1	2	1.50
64	4	0	0	0.00	64	4	0	0	0.00
67	3	1	2	1.50	67	3	1	1	1.00
70	4	0	0	0.00	70	4	0	0	0.00
71	5	0	0	0.00	71	5	0	0	0.00
73	2	1	1	1.00	73	2	1	1	1.00
74	3	1	1	1.00	74	3	1	1	1.00
75	4	1	1	1.00	75	4	1	1	1.00
76	1	1	1	1.00	76	1	1	1	1.00
77	2	2	1	1.50	77	2	1	2	1.50
78	3	1	2	1.50	78	3	2	2	2.00
79	4	0	0	0.00	79	4	0	1	0.50

Appendix 6.2 (Contd.)

Ear No.	Pen	Bursitis score Left	Right	Mean	Ear No.	Pen	Bursitis score Left	Right	Mean
Examination No. 3					**Examination No.4**				
80	5	0	1	0.50	80	5	1	1	1.00
81	1	2	2	2.00	81	1	3	2	2.50
82	2	1	1	1.00	82	2	1	2	1.50
83	3	1	1	1.00	83	3	2	1	1.50
84	4	1	1	1.00	84	4	1	1	1.00
85	2	2	2	2.00	85	2	2	2	2.00
88	3	1	1	1.00	88	3	2	2	2.00
89	2	2	3	2.50	89	2	3	3	3.00
90	3	1	1	1.00	90	3	1	1	1.00
91	5	2	2	2.00	91	5	2	2	2.00
93	5	1	1	1.00	93	5	1	2	1.50
97	5	0	0	0.00	97	5	0	0	0.00
98	5	2	2	2.00	98	5	0	0	0.00
99	5	0	0	0.00	99	5	2	2	2.00
Examination No. 5					**Examination No. 5**				
1	5	2	2	2.00	41	3	2	2	2.00
2	2	1	1	1.00	42	4	0	1	0.50
4	4	0	0	0.00	43	5	1	0	0.50
6	2	0	0	0.00	45	1	1	2	1.50
7	3	2	2	2.00	46	3	3	3	3.00
8	1	1	1	1.00	47	3	1	1	1.00
9	4	0	0	0.00	48	4	0	0	0.00
10	1	1	1	1.00	49	2	0	0	0.00
11	2	0	1	0.50	50	5	1	1	1.00
12	1	2	2	2.00	51	5	1	2	1.50
15	4	1	1	1.00	53	2	1	3	2.00
16	1	1	1	1.00	55	2	2	2	2.00
18	1	1	0	0.50	56	2	2	3	2.50
19	2	1	2	1.50	57	2	2	3	2.50
20	3	1	1	1.00	58	5	2	3	2.50
21	4	0	0	0.00	59	3	2	3	2.50
23	5	1	1	1.00	60	5	2	2	2.00
24	1	1	1	1.00	61	1	0	0	0.00
25	5	3	3	3.00	62	2	1	0	0.50
26	1	2	2	2.00	63	3	1	2	1.50
27	1	2	2	2.00	64	4	0	0	0.00
30	4	1	1	1.00	67	3	1	2	1.50
31	1	1	2	1.50	70	4	0	0	0.00
33	4	0	0	0.00	71	5	1	1	1.00
34	4	0	0	0.00	73	2	1	1	1.00
35	1	1	1	1.00	74	3	1	2	1.50
37	3	1	1	1.00	75	4	1	1	1.00
38	4	0	0	0.00	76	1	1	1	1.00
39	1	1	2	1.50	77	2	1	2	1.50

Appendix 6.2 (Contd.)

Ear No.	Pen	Bursitis score Left	Right	Mean	Ear No.	Pen	Bursitis score Left	Right	Mean
Examination No. 5									
78	3	2	2	2.00	88	3	3	3	3.00
79	4	0	1	0.50	89	2	3	3	3.00
80	5	1	1	1.00	90	3	1	1	1.00
81	1	3	2	2.50	91	5	2	2	2.00
82	2	1	2	1.50	93	5	1	2	1.50
83	3	2	1	1.50	97	5	2	3	2.50
84	4	1	1	1.00	98	5	0	0	0.00
85	2	2	2	2.00	99	5	0	0	0.00

Appendix 7.1: Statistical analysis: The relationship between foor-rot and bursitis.

******* Regression Analysis *******

Response variate	:	inja
Fitted terms	:	Constant, bscore

***** Summary of analysis *****

	d.f.	**s.s.**	**m.s.**	**v.r.**
Regression	1	25.19	25.1878	28.37
Residual	21	18.65	0.8880	
Total	22	43.83	1.9925	

Percentage variance accounted for 55.4

* MESSAGE: The following units have large standardized residuals:

2	2.21

* MESSAGE: The following units have high leverage:

6	0.260

***** Estimates of regression coefficients *****

	Estimate	**s.e.**	**t**
Constant	0.218	0.438	0.50
bscore	1.546	0.290	5.33

******* Regression Analysis *******

Response variate	:	inja
Fitted terms	:	Constant, bscore, bscoresq

Appendix 7.1 (Contd.)

***** Summary of analysis *****

	d.f.	**s.s.**	**m.s.**	**v.r.**
Regression	2	25.57	12.7829	13.99
Residual	20	18.27	0.9134	
Total	22	43.83	1.9925	

Percentage variance accounted for 54.2

* MESSAGE: The following units have large standardized residuals:

2	2.10

* MESSAGE: The following units have high leverage:

6	0.76
20	0.30

***** Estimates of regression coefficients *****

	Estimate	**s.e.**	**t**
Constant	-0.123	0.691	-0.18
bscore	2.21	1.07	2.06
bscoresq	-0.243	0.377	-0.64

Appendix 7.2: The farm ID, foot injuries and mean bursitis score

Farm ID	No. of pigs	injl	injr	injt	inja	bscore
CA	50	35	43	78	1.56	2.023
BB	24	57	56	113	4.71	1.595
WS	43	72	76	148	3.44	1.825
ST	48	42	47	89	1.85	1.500
MI	57	74	100	174	3.05	1.792
NF	31	71	68	139	4.48	2.862
PI	48	108	99	207	4.31	2.164
M1	106	95	134	229	2.16	2.044
X0	68	121	145	266	3.91	2.000
BB	27	57	52	109	4.04	1.390
LA	31	37	38	75	2.42	1.847
MA	74	87	116	203	2.74	1.449
MO	44	5	4	9	0.02	0.376
M1	32	2	7	9	0.28	0.902
5F	36	2	2	4	0.11	0.377
PM	58	52	36	88	1.52	0.782
P5	30	38	39	77	2.56	1.203
KE	34	39	40	79	2.32	1.599
TT	51	69	70	139	2.73	1.200
DA	43	31	31	62	1.44	0.190
GR	46	28	19	47	1.02	0.440
AE	36	10	8	18	0.50	0.588
NO	35	30	34	64	1.83	0.905

injl = no. of injuries left foot
injr = no. of injuries right foot
injt = total no. of injuries
inja = mean no. of injuries
bscore = bursitis score

Appendix 8.1: The sample date, piglet ID, sex, bursitis score of each leg, sow ID, date of birth (litter) and no. born and boar ID.

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
07/11/91	1555	F	1	1	B501	01/22/91	11	716
06/06/91	1556	F	1	1	B501	01/22/91	11	716
07/05/91	1560	F	0	0	B501	01/22/91	11	716
02/22/91	9263	F	1	2	B502	09/30/90	12	845
02/22/91	9267	M	2	2	B502	09/30/90	12	845
02/22/91	9268	M	2	2	B502	09/30/90	12	845
03/08/91	9269	M	1	1	B502	09/30/90	12	845
02/22/91	9270	M	3	2	B502	09/30/90	12	845
02/22/91	9235	F	2	3	B503	09/29/90	10	716
02/22/91	9233	F	2	3	B503	09/29/90	10	716
04/04/91	9771	F	2	2	B504	11/13/90	13	752
04/04/91	9769	F	2	2	B504	11/13/90	13	752
04/04/91	9770	F	2	2	B504	11/13/90	13	752
04/04/91	9773	F	3	2	B504	11/13/90	13	752
04/04/91	9777	F	2	1	B504	11/13/90	13	752
04/04/91	9774	F	1	2	B504	11/13/90	13	752
04/04/91	9775	F	3	2	B504	11/13/90	13	752
04/04/91	9767	F	2	2	B504	11/13/90	13	752
08/16/91	2407	F	1	1	B504	04/09/91	14	716
08/16/91	2414	F	1	2	B504	04/09/91	14	716
08/16/91	2415	M	1	2	B504	04/09/91	14	716
08/16/91	2408	F	1	0	B504	04/09/91	14	716
08/16/91	2409	M	1	2	B504	04/09/91	14	716
08/16/91	2410	F	0	1	B504	04/09/91	14	716
08/16/91	2412	M	1	1	B504	04/09/91	14	716
08/16/91	2413	M	3	3	B504	04/09/91	14	716
07/05/91	1666	F	1	2	B506	02/07/91	14	631
07/05/91	1667	M	2	3	B506	02/07/91	14	631
07/05/91	1668	M	1	2	B506	02/07/91	14	631
07/05/91	1669	F	1	1	B506	02/07/91	14	631
02/22/91	9249	F	2	3	B508	09/29/90	11	741
02/22/91	9259	F	2	2	B508	09/29/90	11	741
02/22/91	9252	F	2	2	B508	09/29/90	11	741
02/22/91	9254	F	2	2	B508	09/29/90	11	741
02/22/91	9257	M	2	2	B508	09/29/90	11	741
02/22/91	9258	F	1	1	B508	09/29/90	11	741
07/26/91	1915	F	1	1	B508	03/10/91	8	835
07/11/91	1920	M	3	3	B508	03/10/91	8	835
07/26/91	1922	F	2	3	B508	03/10/91	8	835
07/19/91	1917	F	2	2	B508	03/10/91	8	835
07/11/91	1918	M	3	2	B508	03/10/91	8	835
05/03/91	1070	F	3	3	B509	12/13/90	10	631
05/24/91	1069	F	1	2	B509	12/13/90	10	631
05/24/91	1066	F	3	2	B509	12/13/90	10	631
05/24/91	1063	M	1	0	B509	12/13/90	10	631
05/10/91	1062	F	3	3	B509	12/13/90	10	631

Appendix 8.1(Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
03/08/91	9567	M	2	2	B510	10/26/90	14	752
03/08/91	9568	F	2	2	B510	10/26/90	14	752
03/08/91	9573	M	1	1	B510	10/26/90	14	752
03/08/91	9579	M	1	1	B510	10/26/90	14	752
03/08/91	9566	M	1	1	B510	10/26/90	14	752
07/26/91	1977	F	1	1	B510	03/14/91	14	631
07/19/91	1981	F	1	1	B510	03/14/91	14	631
07/11/91	1982	M	1	1	B510	03/14/91	14	631
07/26/91	1978	F	0	1	B510	03/14/91	14	631
07/26/91	1979	F	2	2	B510	03/14/91	14	631
07/26/91	1970	M	1	1	B510	03/14/91	14	631
07/19/91	1971	F	2	2	B510	03/14/91	14	631
07/26/91	1973	M	2	2	B510	03/14/91	14	631
07/19/91	1972	F	2	1	B510	03/14/91	14	631
08/12/91	1974	F	1	2	B510	03/14/91	14	631
04/04/91	9594	F	2	5	B512	10/29/90	10	631
07/26/91	2016	M	1	0	B512	03/18/91	14	716
08/12/91	2018	F	2	3	B512	03/18/91	14	716
08/12/91	2020	M	1	1	B512	03/18/91	14	716
07/26/91	2021	M	3	2	B512	03/18/91	14	716
07/19/91	2015	F	1	1	B512	03/18/91	14	716
07/26/91	2011	M	3	3	B512	03/18/91	14	716
02/22/91	9102	F	2	2	B513	09/14/90	11	741
03/01/91	9103	F	2	2	B513	09/14/90	11	741
05/03/91	9866	F	2	2	B516	11/23/90	11	716
04/04/91	9870	F	3	3	B516	11/23/90	11	716
05/03/91	9872	F	1	2	B516	11/23/90	11	716
03/01/91	9187	F	3	2	B518	09/24/90	11	741
02/22/91	9182	F	1	0	B518	09/24/90	11	741
02/22/91	9183	M	1	1	B518	09/24/90	11	741
02/22/91	9189	M	2	2	B518	09/24/90	11	741
03/08/91	9184	F	2	2	B518	09/24/90	11	741
03/08/91	9180	M	1	0	B518	09/24/90	11	741
03/08/91	9185	M	1	2	B518	09/24/90	11	741
02/22/91	9181	M	1	1	B518	09/24/90	11	741
05/24/91	1263	F	1	0	B520	01/03/91	4	631
05/24/91	1264	F	1	1	B520	01/03/91	4	631
05/31/91	1265	F	1	2	B520	01/03/91	4	631
05/24/91	1266	M	1	1	B520	01/03/91	4	631
05/24/91	1023	F	1	1	B521	12/09/90	12	752
05/03/91	1020	F	2	2	B521	12/09/90	12	752
05/03/91	1019	F	1	1	B521	12/09/90	12	752
05/10/91	1017	M	1	1	B521	12/09/90	12	752
05/03/91	1016	F	2	2	B521	12/09/90	12	752
05/31/91	1508	M	1	1	B526	01/16/91	7	631
06/06/91	1510	F	1	2	B526	01/16/91	7	631
06/06/91	1511	M	2	2	B526	01/16/91	7	631
05/31/91	1513	F	2	1	B526	01/16/91	7	631

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
06/06/91	1536	F	2	2	B533	01/17/91	9	716
06/06/91	1539	F	0	1	B533	01/17/91	9	716
05/31/91	1540	M	2	2	B533	01/17/91	9	716
05/31/91	1535	M	2	2	B533	01/17/91	10	716
06/06/91	1541	M	2	3	B533	01/17/91	9	716
07/05/91	1541	F	1	1	B533	01/17/91	9	716
06/06/91	1519	M	0	0	B535	01/16/91	9	631
06/06/91	1516	F	3	3	B535	01/16/91	9	631
06/06/91	1518	M	2	2	B535	01/16/91	9	631
07/05/91	1394	F	1	1	B536	01/10/91	7	337
06/06/91	1395	F	1	2	B536	01/10/91	7	337
06/06/91	1398	F	3	4	B536	01/10/91	7	337
05/31/91	1374	M	3	3	B539	01/05/91	7	716
05/24/91	1377	M	0	0	B539	01/05/91	7	716
06/06/91	1486	F	2	3	B543	01/13/91	13	337
06/06/91	1487	M	1	1	B543	01/13/91	13	337
07/05/91	1489	F	2	2	B543	01/13/91	13	337
05/24/91	1493	M	1	1	B543	01/13/91	13	337
05/31/91	1494	F	2	3	B543	01/13/91	13	337
06/06/91	1495	F	1	2	B543	01/13/91	13	337
06/06/91	1496	M	1	2	B543	01/13/91	13	337
07/05/91	1630	M	2	1	B547	02/01/91	9	845
05/10/91	1200	F	1	1	B548	12/27/90	7	337
05/10/91	1201	F	0	0	B548	12/27/90	7	337
05/10/91	1202	M	1	1	B548	12/27/90	7	337
05/10/91	1205	M	1	1	B548	12/27/90	7	337
05/31/91	1293	F	2	2	B551	01/04/91	14	845
05/24/91	1300	F	0	0	B551	01/04/91	14	845
05/31/91	1301	F	2	1	B551	01/04/91	14	845
05/31/91	1295	M	2	3	B551	01/04/91	14	845
05/31/91	1296	M	1	2	B551	01/04/91	14	845
05/31/91	1297	M	2	2	B551	01/04/91	14	845
05/31/91	1298	M	1	1	B551	01/04/91	14	845
05/31/91	1299	F	3	2	B551	01/04/91	14	845
05/24/91	1127	M	1	1	B559	12/21/90	11	845
05/10/91	1135	M	1	0	B559	12/21/90	11	845
05/10/91	1136	M	2	1	B559	12/21/90	11	845
05/24/91	1137	M	1	1	B559	12/21/90	11	845
05/24/91	1131	M	1	0	B559	12/21/90	11	845
05/24/91	1132	M	0	1	B559	12/21/90	11	845
05/10/91	1133	M	1	1	B559	12/21/90	11	845
05/10/91	1134	F	1	1	B559	12/21/90	11	845
05/24/91	1075	F	1	1	B562	12/14/90	5	337
05/10/91	1074	F	2	2	B562	12/14/90	5	337
05/10/91	1072	M	1	1	B562	12/14/90	5	337
05/03/91	1071	M	1	1	B562	12/14/90	5	337
05/24/91	1059	F	2	2	B564	12/12/90	8	716
05/03/91	1058	F	1	1	B564	12/12/90	8	716

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/10/91	1057	M	2	3	B564	12/12/90	8	716
05/24/91	1056	F	2	3	B564	12/12/90	8	716
05/24/91	1054	M	1	0	B564	12/12/90	8	716
05/10/91	1053	F	1	1	B564	12/12/90	8	716
04/04/91	9675	F	2	2	B569	11/06/90	11	631
04/19/91	9679	F	3	2	B569	11/06/90	11	631
04/04/91	9672	M	2	1	B569	11/06/90	11	631
03/08/91	9308	F	2	2	B571	10/07/90	10	631
03/08/91	9302	F	2	1	B571	10/07/90	10	631
04/04/91	9697	F	0	0	B574	11/08/90	9	752
04/04/91	9698	F	2	2	B574	11/08/90	9	752
04/04/91	9703	F	2	2	B574	11/08/90	9	752
05/10/91	1184	F	2	5	B576	12/27/90	13	631
05/24/91	1176	F	2	2	B576	12/27/90	13	631
05/10/91	1178	F	2	2	B576	12/27/90	13	631
05/10/91	1181	F	1	2	B576	12/27/90	13	631
05/24/91	1183	M	3	3	B576	12/27/90	13	631
04/04/91	9818	M	0	1	B577	11/16/90	9	337
04/04/91	9819	M	1	1	B577	11/16/90	9	337
05/03/91	9820	F	1	2	B577	11/16/90	9	337
04/04/91	9814	F	2	2	B577	11/16/90	9	337
04/04/91	9815	M	1	0	B577	11/16/90	9	337
08/16/91	2442	F	1	1	B577	04/11/91	7	716
08/24/91	2444	M	0	0	B577	04/11/91	7	716
08/16/91	2445	M	0	0	B577	04/11/91	7	716
08/24/91	2446	F	1	1	B577	04/11/91	7	716
08/24/91	2447	F	2	2	B577	04/11/91	7	716
03/01/91	9616	M	2	2	B581	11/01/90	10	752
04/04/91	9620	F	2	2	B581	11/01/90	10	752
08/12/91	2138	M	1	0	B581	03/21/91	9	741
08/16/91	2139	F	0	0	B581	03/21/91	9	741
03/08/91	9457	M	1	1	B589	10/12/90	12	631
03/08/91	9447	F	0	0	B589	10/12/90	12	631
02/22/91	9448	F	2	1	B589	10/12/90	12	631
03/01/91	9449	M	2	2	B589	10/12/90	12	631
07/26/91	9453	M	1	0	B589	10/12/90	12	631
08/16/91	1943	M	1	0	B589	03/09/91	5	370
08/16/91	1945	F	0	1	B589	03/09/91	5	370
03/01/91	9343	F	1	1	B593	10/08/90	13	741
03/01/91	9345	F	1	1	B593	10/08/90	13	741
03/01/91	9346	M	2	2	B593	10/08/90	13	741
03/08/91	9348	M	1	1	B593	10/08/90	13	741
07/11/91	1845	M	2	2	B593	03/01/91	11	741
07/05/91	1843	F	1	2	B593	03/01/91	11	741
07/05/91	1844	M	2	2	B593	03/01/91	11	741
07/11/91	1842	M	2	2	B593	03/01/91	11	741
03/01/91	9439	F	1	1	B595	10/12/90	8	752
02/22/91	9444	M	1	1	B595	10/12/90	8	752

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
07/19/91	1913	F	1	2	B595	03/10/91	7	631
07/19/91	1910	M	4	4	B595	03/10/91	7	631
03/01/91	9464	F	1	1	B596	10/11/90	10	845
03/01/91	9463	F	0	1	B596	10/11/90	10	845
02/22/91	9466	M	1	1	B596	10/11/90	10	845
03/08/91	9459	M	1	1	B596	10/11/90	10	845
05/03/91	1081	F	1	1	B603	12/13/90	9	631
04/19/91	1080	M	2	2	B603	12/13/90	9	631
05/31/91	1079	M	2	2	B603	12/13/90	9	631
05/24/91	1077	M	1	2	B603	12/13/90	9	631
04/04/91	9395	M	3	3	B605	10/10/90	10	835
02/22/91	9393	M	3	3	B605	10/10/90	10	835
03/01/91	9394	F	3	2	B605	10/10/90	10	835
03/08/91	9388	F	2	2	B605	10/10/90	10	835
03/01/91	9389	M	2	2	B605	10/10/90	10	835
04/04/91	9391	M	3	3	B605	10/10/90	10	835
02/22/91	9326	F	2	1	B608	10/07/90	7	752
03/01/91	9323	M	1	0	B608	10/07/90	7	752
04/04/91	9638	F	1	1	B610	11/03/90	9	835
04/19/91	9636	M	1	2	B610	11/03/90	9	835
03/01/91	9637	M	1	1	B610	11/03/90	9	835
08/12/91	2172	F	2	3	B610	03/22/91	11	845
07/19/91	2171	M	2	2	B610	03/22/91	11	845
07/26/91	2173	F	2	2	B610	03/22/91	11	845
05/10/91	9844	M	1	1	B611	11/23/90	11	337
04/19/91	9852	F	3	2	B611	11/23/90	11	337
08/24/91	2456	M	2	2	B611	04/13/91	10	716
04/19/91	9780	F	1	0	B612	11/19/90	9	839
04/19/91	9786	F	1	1	B612	11/19/90	9	839
04/04/91	9789	F	1	1	B612	11/19/90	9	839
04/19/91	9783	F	3	3	B612	11/19/90	9	839
08/24/91	2359	F	3	3	B612	04/03/91	13	845
08/16/91	2360	M	2	3	B612	04/03/91	13	845
08/24/91	2361	M	3	3	B612	04/03/91	13	845
08/12/91	2352	M	3	3	B612	04/03/91	13	845
08/24/91	2362	F	2	2	B612	04/03/91	13	845
08/24/91	2353	F	2	2	B612	04/03/91	13	845
08/24/91	2354	M	2	2	B612	04/03/91	13	845
08/12/91	2355	M	3	3	B612	04/03/91	13	845
08/24/91	2356	M	3	3	B612	04/03/91	13	845
08/24/91	2350	M	2	2	B612	04/03/91	13	845
08/12/91	2357	F	2	3	B612	04/03/91	13	845
08/16/91	2351	F	3	4	B612	04/03/91	13	845
04/04/91	9658	M	1	1	B613	11/06/90	18	337
05/03/91	9651	F	2	2	B613	11/06/90	18	337
04/04/91	9654	F	2	2	B613	11/06/90	18	337
04/19/91	9654	M	2	2	B613	11/06/90	18	337
04/19/91	9646	M	3	3	B613	11/06/90	18	337

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
04/04/91	9647	F	2	2	B613	11/06/90	18	337
05/03/91	9657	M	1	2	B613	11/06/90	18	337
04/19/91	9649	F	3	2	B613	11/06/90	18	337
04/19/91	9650	F	2	2	B613	11/06/90	18	337
04/04/91	9655	M	2	2	B613	11/06/90	18	337
08/12/91	2312	F	3	3	B613	03/31/91	13	785
08/12/91	2319	F	1	1	B613	03/31/91	13	785
08/24/91	2313	M	1	1	B613	03/31/91	13	785
08/24/91	2317	M	1	1	B613	03/31/91	13	785
08/24/91	2318	F	1	1	B613	03/31/91	13	785
08/12/91	2308	M	1	1	B613	03/31/91	13	785
08/24/91	2309	F	2	1	B613	03/31/91	13	785
05/24/91	1448	F	2	2	B615	01/11/91	12	631
05/24/91	1251	M	3	3	B616	01/03/91	11	752
05/24/91	1252	M	2	2	B616	01/03/91	11	752
05/24/91	1253	M	2	2	B616	01/03/91	11	752
05/24/91	1254	M	1	2	B616	01/03/91	11	752
02/22/91	9197	M	1	1	B618	09/26/90	8	631
03/08/91	9190	M	3	3	B618	09/26/90	8	631
03/08/91	9191	M	2	1	B618	09/26/90	8	631
02/22/91	9196	F	1	1	B618	09/26/90	8	631
03/01/91	9365	F	2	3	B620	10/08/90	15	845
07/05/91	1799	F	2	2	B620	03/01/91	15	835
07/05/91	1800	F	2	2	B620	03/01/91	15	835
07/05/91	1801	F	1	1	B620	03/01/91	15	835
07/05/91	1807	M	3	2	B620	03/01/91	15	835
07/11/91	1811	M	2	2	B620	03/01/91	15	835
03/01/91	9329	F	3	2	B622	10/08/90	11	845
03/01/91	9331	M	2	3	B622	10/08/90	11	845
03/01/91	9332	F	3	3	B622	10/08/90	11	845
03/01/91	9338	F	3	2	B622	10/08/90	11	845
03/01/91	9339	M	3	3	B622	10/08/90	11	845
03/01/91	9333	M	2	2	B622	10/08/90	11	845
03/01/91	9334	M	4	3	B622	10/08/90	11	845
03/01/91	9335	M	2	3	B622	10/08/90	11	845
03/01/91	9336	F	2	2	B622	10/08/90	11	845
03/01/91	9337	F	3	2	B622	10/08/90	11	845
07/19/91	1822	F	1	2	B622	02/28/91	11	631
08/12/91	1823	M	1	2	B622	02/28/91	11	631
02/22/91	9198	F	1	1	B625	09/26/90	10	741
03/01/91	9199	F	2	1	B625	09/26/90	10	741
03/01/91	9203	M	3	2	B625	09/26/90	10	741
03/01/91	9206	F	0	1	B625	09/26/90	10	741
07/11/91	1733	F	2	1	B625	02/14/91	14	741
07/11/91	1735	M	0	0	B625	02/14/91	14	741
07/11/91	1732	F	2	1	B625	02/14/91	14	741
07/05/91	1724	M	1	1	B625	02/14/91	14	741
07/05/91	1728	M	1	2	B625	02/14/91	14	741

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
04/04/91	9800	M	1	2	B626	11/18/90	13	835
04/04/91	9802	M	3	3	B626	11/18/90	13	835
04/19/91	9804	F	1	2	B626	11/18/90	13	835
04/19/91	9805	F	3	3	B626	11/18/90	13	835
04/19/91	9806	F	3	3	B626	11/18/90	13	835
04/04/91	9808	F	2	1	B626	11/18/90	13	835
08/16/91	2435	F	2	2	B626	04/11/91	11	845
08/24/91	2436	F	2	2	B626	04/11/91	11	845
08/16/91	2437	F	2	3	B626	04/11/91	11	845
08/16/91	2438	F	2	2	B626	04/11/91	11	845
08/24/91	2440	M	2	2	B626	04/11/91	11	845
08/24/91	2433	M	2	2	B626	04/11/91	11	845
08/16/91	2434	M	2	2	B626	04/11/91	11	845
04/04/91	9607	F	1	1	B627	11/01/90	11	845
05/03/91	9609	M	1	1	B627	11/01/90	11	845
04/04/91	9610	F	2	2	B627	11/01/90	11	845
08/12/91	2152	F	1	2	B627	03/22/91	14	370
08/12/91	2155	F	2	1	B627	03/22/91	14	370
08/12/91	2147	M	2	2	B627	03/22/91	14	370
08/12/91	2148	F	2	2	B627	03/22/91	14	370
08/12/91	2156	F	1	1	B627	03/22/91	14	370
03/08/91	9584	F	2	1	B628	10/26/90	5	845
07/26/91	2045	M	3	3	B628	03/15/91	10	741
04/19/91	9662	M	2	2	B629	11/06/90	11	835
04/04/91	9664	F	2	2	B629	11/06/90	11	835
05/03/91	1035	M	1	1	B630	12/09/90	3	741
04/19/91	9825	M	1	2	B632	11/21/90	12	631
04/19/91	9829	F	1	1	B632	11/21/90	12	631
04/19/91	9833	F	0	1	B632	11/21/90	12	631
08/16/91	2416	M	1	1	B632	04/11/91	14	631
08/24/91	2417	F	1	1	B632	04/11/91	14	631
08/24/91	2422	F	1	2	B632	04/11/91	14	631
08/24/91	2427	M	1	1	B632	04/11/91	14	631
04/04/91	9758	F	1	1	B633	11/13/90	11	716
04/04/91	9759	F	0	2	B633	11/13/90	11	716
04/19/91	9764	F	2	2	B633	11/13/90	11	716
04/04/91	9766	M	0	1	B633	11/13/90	11	716
05/03/91	9757	M	1	2	B633	11/13/90	11	716
08/24/91	2449	F	2	1	B633	04/12/91	7	845
08/16/91	2451	M	3	3	B633	04/12/91	7	845
04/19/91	9744	M	2	1	B634	11/13/90	13	716
04/04/91	9745	F	2	1	B634	11/13/90	13	716
04/19/91	9748	F	2	2	B634	11/13/90	13	716
04/19/91	9755	F	2	2	B634	11/13/90	13	716
04/19/91	9743	F	2	2	B634	11/13/90	13	716
04/04/91	9749	M	2	2	B634	11/13/90	13	716
04/19/91	9754	F	2	2	B634	11/13/90	13	716
04/19/91	9747	F	3	3	B634	11/13/90	13	716

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/10/91	1031	F	2	2	B635	12/09/90	8	337
07/05/91	1032	M	2	2	B635	12/09/90	8	337
05/03/91	9836	M	0	0	B636	11/22/90	10	785
06/06/91	1600	F	1	0	B638	01/25/91	9	337
06/06/91	1602	M	2	2	B638	01/25/91	9	337
05/31/91	1603	F	1	2	B638	01/25/91	9	337
06/06/91	1605	M	1	1	B638	01/25/91	9	337
06/06/91	1598	F	1	1	B638	01/25/91	9	337
03/01/91	9040	F	2	2	B636	09/09/90	12	716
03/08/91	9280	M	3	3	B639	10/02/90	12	716
07/11/91	1827	F	2	2	B639	03/01/91	14	785
03/08/91	9596	M	2	2	B640	10/29/90	6	716
07/26/91	2041	F	1	2	B640	03/14/91	11	716
07/11/91	2035	M	3	2	B640	03/14/91	11	716
02/22/91	9083	M	2	1	B641	09/12/90	13	631
03/08/91	9084	M	2	2	B641	09/12/90	13	631
03/08/91	9086	M	1	1	B641	09/12/90	13	631
02/22/91	9087	F	2	3	B641	09/12/90	13	631
02/22/91	9088	F	2	1	B641	09/12/90	13	631
07/05/91	1690	M	2	1	B641	02/07/91	11	716
07/05/91	1691	M	2	3	B641	02/07/91	11	716
06/06/91	1586	F	2	2	B642	01/25/91	14	631
06/06/91	1589	F	2	1	B642	01/25/91	14	631
06/06/91	1590	F	2	2	B642	01/25/91	14	631
07/05/91	1591	M	2	2	B642	01/25/91	14	631
06/06/91	1592	F	1	1	B642	01/25/91	14	631
06/06/91	1596	M	1	2	B642	01/25/91	14	631
06/06/91	1597	M	2	1	B642	01/25/91	14	631
05/10/91	9963	F	2	2	B644	12/04/90	14	835
05/03/91	9967	F	1	0	B644	12/04/90	14	835
05/03/91	9955	M	2	2	B644	12/04/90	14	835
05/03/91	9956	M	2	1	B644	12/04/90	14	835
05/10/91	9957	M	2	2	B644	12/04/90	14	835
05/03/91	9958	M	1	2	B644	12/04/90	14	835
05/24/91	9960	F	2	2	B644	12/04/90	14	835
05/31/91	1155	M	3	3	B645	12/24/90	12	785
05/10/91	1156	F	2	2	B645	12/24/90	12	785
05/10/91	1157	F	4	3	B645	12/24/90	12	785
05/10/91	1158	M	3	3	B645	12/24/90	12	785
06/06/91	1151	F	2	2	B645	12/24/90	12	785
06/06/91	1152	F	2	2	B645	12/24/90	12	785
05/24/91	1154	M	2	3	B645	12/24/90	12	785
05/24/91	1155	M	3	3	B645	12/24/90	12	785
05/24/91	1160	M	3	2	B645	12/24/90	12	785
05/24/91	1159	F	2	3	B645	12/24/90	12	785
05/03/91	9979	M	2	2	B646	12/04/90	12	631
05/03/91	9975	F	1	1	B646	12/04/90	12	631
04/19/91	9977	F	0	0	B646	12/04/90	12	631

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Bursitis score Right	Sow ID	Date of birth	No. born	Boar ID
03/08/91	9542	M	1	1	B647	10/26/90	12	741
03/08/91	9543	M	1	1	B647	10/26/90	12	741
04/04/91	9544	M	1	1	B647	10/26/90	12	741
03/01/91	9535	M	2	2	B647	10/26/90	12	741
03/08/91	9537	M	0	1	B647	10/26/90	12	741
04/04/91	9538	F	1	1	B647	10/26/90	12	741
08/12/91	2066	M	1	1	B647	03/16/91	16	741
08/12/91	2070	M	2	2	B647	03/16/91	16	741
07/26/91	2065	F	3	1	B647	03/16/91	16	741
07/19/91	2064	M	1	2	B647	03/16/91	16	741
08/12/91	2071	M	3	3	B647	03/16/91	16	741
07/19/91	2072	M	2	2	B647	03/16/91	16	741
07/19/91	2067	M	1	0	B647	03/16/91	16	741
07/19/91	2068	F	2	2	B647	03/16/91	16	741
07/19/91	2069	M	2	1	B647	03/16/91	16	741
03/08/91	9559	F	3	3	B648	10/26/90	7	845
04/04/91	9560	F	3	3	B648	10/26/90	7	845
07/19/91	2085	M	2	3	B648	03/16/91	13	839
07/26/91	2084	F	1	2	B648	03/16/91	13	839
07/11/91	2084	M	2	2	B648	03/16/91	13	839
08/16/91	2081	M	3	3	B648	03/16/91	13	839
05/31/91	1233	M	1	2	B649	01/03/91	8	835
05/31/91	1234	M	2	2	B649	01/03/91	8	835
05/31/91	1235	M	1	2	B649	01/03/91	8	835
05/24/91	1236	F	5	3	B649	01/03/91	8	835
05/31/91	1237	M	1	1	B649	01/03/91	8	835
02/22/91	9049	M	3	3	B651	09/11/90	11	845
02/22/91	9051	F	2	2	B651	09/11/90	11	845
05/24/91	1310	F	3	3	B654	01/06/91	8	752
05/31/91	1311	F	3	3	B654	01/06/91	8	752
05/24/91	1312	M	3	3	B654	01/06/91	8	752
05/31/91	1314	M	2	2	B654	01/06/91	8	752
05/31/91	1218	M	0	1	B655	12/27/90	15	631
05/31/91	1219	M	1	1	B655	12/27/90	15	631
05/24/91	1220	M	2	2	B655	12/27/90	15	631
05/10/91	1231	F	1	1	B655	12/27/90	15	631
05/24/91	1232	F	2	2	B655	12/27/90	15	631
05/24/91	1227	F	1	1	B655	12/27/90	15	631
05/10/91	1230	F	1	1	B655	12/27/90	15	631
05/10/91	1222	F	1	1	B655	12/27/90	15	631
05/10/91	1223	F	1	1	B655	12/27/90	15	631
05/24/91	1224	M	0	0	B655	12/27/90	15	631
05/24/91	1226	F	1	0	B655	12/27/90	15	631
05/31/91	1208	F	2	1	B656	12/27/90	13	785
05/24/91	1209	M	2	1	B656	12/27/90	13	785
05/31/91	1211	F	1	1	B656	12/27/90	13	785
05/24/91	1213	F	1	2	B656	12/27/90	13	785
05/10/91	1216	F	2	2	B656	12/27/90	13	785

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/31/91	1217	F	2	2	B656	12/27/90	13	785
05/31/91	1207	M	2	2	B656	12/27/90	13	785
02/22/91	9246	M	3	3	B657	09/29/90	13	835
02/22/91	9236	M	2	3	B657	09/29/90	13	835
02/22/91	9239	F	2	3	B657	09/29/90	13	835
02/22/91	9243	M	2	2	B657	09/29/90	13	835
02/22/91	9244	M	3	3	B657	09/29/90	13	835
07/05/91	1570	M	2	2	B658	01/23/91	12	337
05/24/91	1564	M	2	2	B658	01/23/91	12	337
06/06/91	1571	F	1	2	B658	01/23/91	12	337
06/06/91	1572	F	2	3	B658	01/23/91	12	337
05/24/91	1567	F	2	2	B658	01/23/91	12	337
03/08/91	9397	F	2	2	B659	10/10/90	10	631
02/22/91	9399	M	3	3	B659	10/10/90	10	631
02/22/91	9400	M	3	4	B659	10/10/90	10	631
03/01/91	9016	F	1	1	B661	09/04/90	11	716
05/10/91	1190	M	2	1	B662	12/27/90	14	752
05/31/91	1191	F	1	1	B662	12/27/90	14	752
05/24/91	1193	M	1	1	B662	12/27/90	14	752
05/10/91	1194	F	1	1	B662	12/27/90	14	752
05/10/91	1196	M	1	1	B662	12/27/90	14	752
05/10/91	1198	F	1	1	B662	12/27/90	14	752
05/10/91	1145	F	2	2	B663	12/24/90	13	741
05/24/91	1146	F	0	1	B663	12/24/90	13	741
05/10/91	1147	M	1	1	B663	12/24/90	13	741
06/06/91	1147	M	1	2	B663	12/24/90	13	741
05/10/91	1149	F	1	1	B663	12/24/90	13	741
05/10/91	1150	F	0	0	B663	12/24/90	13	741
05/31/91	1148	F	2	3	B663	12/24/90	13	741
05/10/91	1138	F	1	1	B663	12/24/90	13	741
05/10/91	1139	F	1	1	B663	12/24/90	13	741
05/31/91	1140	M	0	1	B663	12/24/90	13	741
05/10/91	1141	F	1	1	B663	12/24/90	13	741
05/24/91	1143	M	1	0	B663	12/24/90	13	741
03/08/91	9421	F	2	2	B664	10/10/90	4	631
03/01/91	9422	M	2	2	B664	10/10/90	4	631
03/01/91	9423	F	2	2	B664	10/10/90	4	631
03/08/91	9549	M	2	3	B666	10/26/90	12	631
03/08/91	9552	F	2	2	B666	10/26/90	12	631
03/08/91	9558	M	2	2	B666	10/26/90	12	631
03/08/91	9550	M	2	2	B666	10/26/90	12	631
03/08/91	9551	M	2	2	B666	10/26/90	12	631
07/26/91	2056	F	3	3	B666	03/17/91	9	845
07/19/91	2058	M	2	1	B666	03/17/91	9	845
07/26/91	2062	M	4	4	B666	03/17/91	9	845
08/24/91	2063	M	2	1	B666	03/17/91	9	845
05/03/91	9932	F	3	3	B667	11/30/90	12	845
04/19/91	9922	F	3	3	B667	11/30/90	12	845

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/10/91	9927	M	3	3	B667	11/30/90	12	845
05/24/91	9930	F	1	1	B667	11/30/90	12	845
03/01/91	9383	F	1	1	B668	10/10/90	10	716
03/01/91	9384	F	1	1	B668	10/10/90	10	716
02/22/91	9386	M	2	2	B668	10/10/90	10	716
02/22/91	9381	F	2	0	B668	10/10/90	10	716
02/22/91	9377	M	2	1	B668	10/10/90	10	716
02/22/91	9380	M	1	1	B668	10/10/90	10	716
02/22/91	9382	M	1	2	B668	10/10/90	10	716
03/08/91	9136	M	2	2	B669	09/19/90	6	845
07/05/91	1708	F	2	2	B669	02/08/91	14	741
07/11/91	1708	F	1	1	B669	02/08/91	14	741
08/24/91	1711	F	1	2	B669	02/08/91	14	741
07/19/91	1718	M	1	0	B669	02/08/91	14	741
06/06/91	1381	F	2	3	B670	01/09/91	15	845
06/06/91	1383	F	3	3	B670	01/09/91	15	845
05/24/91	1384	M	1	1	B670	01/09/91	15	845
05/31/91	1385	F	3	4	B670	01/09/91	15	845
05/24/91	1386	M	3	3	B670	01/09/91	15	845
05/31/91	1387	M	2	3	B670	01/09/91	15	845
05/31/91	1389	F	2	3	B670	01/09/91	15	845
05/24/91	1390	M	1	3	B670	01/09/91	15	845
05/31/91	1392	F	2	2	B670	01/09/91	15	845
06/06/91	1378	M	3	3	B670	01/09/91	15	845
05/31/91	1388	F	3	3	B670	01/09/91	15	845
04/19/91	9859	F	2	2	B671	11/23/90	9	716
04/04/91	9857	F	3	3	B671	11/23/90	9	716
04/19/91	9861	F	2	2	B671	11/23/90	9	716
05/10/91	1276	M	1	1	B672	01/04/91	14	835
05/31/91	1282	M	3	3	B672	01/04/91	14	835
05/24/91	1283	F	1	2	B672	01/04/91	14	835
05/31/91	1284	F	1	2	B672	01/04/91	14	835
05/31/91	1110	F	1	1	B673	12/16/90	11	741
05/10/91	1109	F	3	2	B673	12/16/90	11	741
05/10/91	1106	F	2	1	B673	12/16/90	11	741
05/10/91	1105	F	2	2	B673	12/16/90	11	741
05/10/91	1104	F	2	2	B673	12/16/90	11	741
05/31/91	1103	F	1	1	B673	12/16/90	11	741
05/10/91	1102	F	3	2	B673	12/16/90	11	741
05/10/91	1101	M	0	1	B673	12/16/90	11	741
05/31/91	1099	M	2	2	B673	12/16/90	11	741
05/24/91	1543	F	2	3	B674	01/21/91	3	716
06/06/91	1544	M	1	2	B674	01/21/91	3	716
05/10/91	1120	F	0	0	B675	12/20/90	9	716
05/10/91	1120	F	1	1	B675	12/20/90	9	716
05/10/91	1121	M	1	1	B675	12/20/90	9	716
05/31/91	1126	F	1	1	B675	12/20/90	9	716
08/24/91	2382	F	1	2	B676	04/08/91	9	845

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
08/16/91	2383	F	3	3	B676	04/08/91	9	845
08/24/91	2385	M	2	2	B676	04/08/91	9	845
08/16/91	2386	M	2	2	B676	04/08/91	9	845
08/24/91	2386	M	3	3	B676	04/08/91	9	845
08/24/91	2401	M	2	2	B677	04/08/91	13	845
08/24/91	2389	M	2	1	B677	04/08/91	13	845
08/24/91	2393	M	2	1	B677	04/08/91	13	845
08/16/91	2394	M	2	2	B677	04/08/91	13	845
08/16/91	2395	F	1	1	B677	04/08/91	13	845
08/24/91	2396	F	2	2	B677	04/08/91	13	845
08/16/91	2398	M	3	3	B677	04/08/91	13	845
08/24/91	2399	F	2	2	B677	04/08/91	13	845
08/24/91	2400	M	1	2	B677	04/08/91	13	845
04/19/91	1091	F	1	1	B678	12/13/90	7	835
05/03/91	1085	F	1	0	B678	12/13/90	7	835
05/03/91	9990	F	3	3	B680	12/07/90	10	839
05/03/91	9991	F	2	2	B680	12/07/90	10	839
05/24/91	9994	F	2	3	B680	12/07/90	10	839
05/03/91	9995	F	2	1	B680	12/07/90	10	839
05/10/91	9997	F	2	2	B680	12/07/90	10	839
05/03/91	9998	F	2	2	B680	12/07/90	10	839
05/31/91	1289	F	2	1	B683	01/04/91	7	785
05/24/91	1290	M	2	2	B683	01/04/91	7	785
02/22/91	9163	F	1	1	B684	09/21/90	15	716
07/05/91	1750	M	2	2	B684	02/17/91	13	785
07/11/91	1751	F	2	2	B684	02/17/91	13	785
07/11/91	1755	F	2	2	B684	02/17/91	13	785
07/05/91	1757	M	1	1	B684	02/17/91	13	785
06/06/91	1524	F	2	2	B685	01/17/91	12	337
06/06/91	1525	F	2	2	B685	01/17/91	12	337
06/06/91	1526	M	2	3	B685	01/17/91	12	337
06/06/91	1531	M	2	2	B685	01/17/91	12	337
05/31/91	1244	M	1	1	B686	01/03/91	10	716
05/31/91	1247	F	2	3	B686	01/03/91	10	716
05/31/91	1248	M	2	2	B686	01/03/91	10	716
05/24/91	1249	F	2	2	B686	01/03/91	10	716
05/31/91	1241	F	1	1	B686	01/03/91	10	716
05/31/91	1242	M	2	2	B686	01/03/91	10	716
05/31/91	1243	M	1	1	B686	01/03/91	10	716
08/16/91	2241	F	2	2	B687	03/24/91	9	845
08/12/91	2243	M	3	3	B687	03/24/91	9	845
08/24/91	2238	M	2	2	B687	03/24/91	9	845
08/12/91	2235	F	1	3	B687	03/24/91	9	845
08/12/91	2240	M	2	2	B687	03/24/91	9	845
08/16/91	2236	F	2	2	B687	03/24/91	9	845
06/06/91	1582	M	1	2	B688	01/25/91	10	785
06/06/91	1575	F	2	2	B688	01/25/91	10	785
06/06/91	1577	M	2	2	B688	01/25/91	10	785

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
06/06/91	1580	M	2	2	B688	01/25/91	10	785
02/22/91	9415	M	2	2	B689	10/10/90	13	839
02/22/91	9408	M	2	2	B689	10/10/90	13	839
02/22/91	9417	M	1	2	B689	10/10/90	13	839
02/22/91	9410	F	2	2	B689	10/10/90	13	839
02/22/91	9411	F	2	2	B689	10/10/90	13	839
02/22/91	9412	F	2	2	B689	10/10/90	13	839
03/01/91	9416	M	3	2	B689	10/10/90	13	839
08/16/91	1868	M	1	1	B689	03/07/91	12	741
08/16/91	1874	F	1	1	B689	03/07/91	12	741
07/11/91	1866	F	2	2	B689	03/07/91	12	741
08/16/91	1867	M	0	0	B689	03/07/91	12	741
08/16/91	1869	F	1	1	B689	03/07/91	12	741
08/16/91	1870	F	0	0	B689	03/07/91	12	741
08/16/91	1872	F	1	1	B689	03/07/91	12	741
03/01/91	9357	F	2	2	B690	10/08/90	9	839
03/01/91	9360	F	2	2	B690	10/08/90	9	839
03/01/91	9353	F	2	2	B690	10/08/90	9	839
02/22/91	9113	M	3	3	B691	09/12/90	3	741
02/22/91	9115	M	3	3	B691	09/12/90	3	741
05/31/91	1273	F	2	2	B692	01/03/91	8	839
05/31/91	1274	F	2	2	B692	01/03/91	8	839
05/31/91	1268	F	2	2	B692	01/03/91	8	839
05/31/91	1271	F	2	2	B692	01/03/91	8	839
05/31/91	1272	F	2	2	B692	01/03/91	8	839
03/01/91	9428	M	4	4	B693	10/10/90	15	839
02/22/91	9432	M	2	2	B693	10/10/90	15	839
03/01/91	9433	F	2	2	B693	10/10/90	15	839
03/01/91	9427	M	2	3	B693	10/10/90	15	839
03/01/91	9437	F	3	3	B693	10/10/90	15	839
07/11/91	1791	M	1	1	B693	02/28/91	14	375
07/11/91	1794	M	2	1	B693	02/28/91	14	375
07/11/91	1798	M	1	1	B693	02/28/91	14	375
07/05/91	1655	F	3	3	B694	02/07/91	9	631
07/05/91	1657	M	3	3	B694	02/07/91	9	631
07/05/91	1651	F	3	3	B694	02/07/91	9	631
07/05/91	1654	F	3	2	B694	02/07/91	9	631
07/11/91	1654	M	2	2	B694	02/07/91	9	631
02/22/91	9141	F	2	3	B695	09/19/90	8	835
02/22/91	9139	F	1	1	B695	09/19/90	8	835
07/11/91	1673	F	2	2	B695	02/07/91	11	785
07/05/91	1676	M	1	1	B695	02/07/91	11	785
07/05/91	1678	F	2	2	B695	02/07/91	11	785
02/22/91	9169	F	2	2	B696	09/21/90	10	835
07/05/91	1736	M	1	2	B696	02/17/91	9	716
07/05/91	1740	F	2	2	B696	02/17/91	9	716
07/05/91	1741	F	2	2	B696	02/17/91	9	716
07/11/91	1743	M	2	1	B696	02/17/91	9	716

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
02/22/91	9153	M	2	2	B697	09/19/90	8	785
07/11/91	1707	F	2	2	B697	02/07/91	12	835
07/05/91	1700	M	2	2	B697	02/07/91	12	835
07/11/91	1704	F	2	1	B697	02/07/91	12	835
07/05/91	1699	M	2	1	B697	02/07/91	12	835
02/22/91	9226	F	3	2	B699	09/26/90	6	835
02/22/91	9220	F	2	3	B699	09/26/90	6	835
03/08/91	9224	F	3	2	B699	09/26/90	6	835
08/16/91	2265	F	1	2	B699	03/26/91	15	741
08/16/91	2272	F	1	1	B699	03/26/91	15	741
08/24/91	2275	F	2	1	B699	03/26/91	15	741
08/12/91	2266	M	2	2	B699	03/26/91	15	741
08/16/91	2267	M	1	1	B699	03/26/91	15	741
08/24/91	2268	F	1	3	B699	03/26/91	15	741
08/16/91	2269	F	2	2	B699	03/26/91	15	741
08/16/91	2271	M	1	2	B699	03/26/91	15	741
08/12/91	2262	M	2	1	B699	03/26/91	15	741
08/12/91	2263	M	2	2	B699	03/26/91	15	741
08/24/91	2264	M	1	2	B699	03/26/91	15	741
03/01/91	9478	F	2	2	B700	10/16/90	5	785
03/08/91	9480	M	1	2	B700	10/16/90	5	785
03/01/91	9481	F	1	1	B700	10/16/90	5	785
03/08/91	9477	F	1	1	B700	10/16/90	5	785
07/19/91	1898	F	2	2	B700	03/06/91	11	845
08/16/91	1900	F	1	1	B700	03/06/91	11	845
08/16/91	1893	M	1	2	B700	03/06/91	11	845
07/19/91	1894	M	2	1	B700	03/06/91	11	845
07/26/91	1901	M	2	2	B700	03/06/91	11	845
08/16/91	1902	F	2	2	B700	03/06/91	11	845
08/16/91	1895	F	2	2	B700	03/06/91	11	845
08/16/91	1896	F	2	2	B700	03/06/91	11	845
08/12/91	1897	F	2	3	B700	03/06/91	11	845
02/22/91	9487	M	1	1	B701	10/12/90	7	839
07/11/91	1905	M	3	2	B701	03/10/91	5	845
07/11/91	1904	M	1	1	B701	03/10/91	5	845
07/19/91	1906	M	2	1	B701	03/10/91	5	845
03/08/91	9524	F	2	2	B702	10/23/90	9	835
03/08/91	9519	F	1	1	B702	10/23/90	9	835
07/19/91	1965	M	1	1	B702	03/14/91	5	785
07/26/91	1965	M	2	2	B702	03/14/91	5	785
03/08/91	9503	M	2	2	B703	10/15/90	5	835
02/22/91	9504	M	2	2	B703	10/15/90	5	835
08/24/91	1927	F	1	2	B703	03/10/91	10	370
07/26/91	1929	F	1	2	B703	03/10/91	10	370
07/19/91	1930	M	2	2	B703	03/10/91	10	370
07/19/91	1925	M	2	2	B703	03/10/91	10	370
07/26/91	1931	F	3	2	B703	03/10/91	10	370
07/19/91	1932	M	2	2	B703	03/10/91	10	370

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
08/16/91	1926	F	1	2	B703	03/10/91	10	370
04/04/91	9496	M	3	2	B704	10/17/90	7	785
03/08/91	9497	M	3	2	B704	10/17/90	7	785
03/08/91	9500	F	2	1	B704	10/17/90	7	785
07/26/91	1933	M	3	3	B704	03/10/91	8	375
07/19/91	1935	F	2	3	B704	03/10/91	8	375
03/08/91	9474	F	2	1	B705	10/17/90	8	785
03/08/91	9475	M	1	2	B705	10/17/90	8	785
08/16/91	1876	M	3	3	B705	03/07/91	7	785
07/19/91	1878	M	2	3	B705	03/07/91	7	785
08/12/91	1881	F	2	3	B705	03/07/91	7	785
04/19/91	9714	F	2	3	B706	11/12/90	11	835
04/19/91	9720	F	2	2	B706	11/12/90	11	835
08/24/91	2341	M	2	2	B706	04/04/91	10	375
08/16/91	2346	M	2	2	B706	04/04/91	10	375
08/16/91	2340	M	2	2	B706	04/04/91	10	375
08/24/91	2346	M	2	1	B706	04/04/91	10	375
08/24/91	2347	M	2	2	B706	04/04/91	10	375
08/24/91	2348	F	2	2	B706	04/04/91	10	375
04/04/91	9706	M	2	2	B707	11/12/90	10	835
04/04/91	9711	F	2	2	B707	11/12/90	10	835
04/19/91	9712	M	3	3	B707	11/12/90	10	835
04/19/91	9713	F	2	2	B707	11/12/90	10	835
08/16/91	2373	F	2	2	B707	04/07/91	7	839
08/24/91	2374	F	2	2	B707	04/07/91	7	839
08/16/91	2375	M	2	2	B707	04/07/91	7	839
08/16/91	2376	M	3	2	B707	04/07/91	7	839
08/24/91	2377	F	2	2	B707	04/07/91	7	839
08/24/91	2378	F	2	2	B707	04/07/91	7	839
04/04/91	9733	M	2	3	B708	11/12/90	10	835
04/19/91	9735	M	3	2	B708	11/12/90	10	835
04/04/91	9737	F	2	3	B708	11/12/90	10	835
04/04/91	9738	M	2	1	B708	11/12/90	10	835
04/04/91	9734	M	2	1	B708	11/12/90	10	835
04/19/91	9741	F	1	1	B708	11/12/90	10	835
04/04/91	9742	F	1	2	B708	11/12/90	10	835
08/12/91	2370	M	3	3	B708	04/03/91	10	835
08/12/91	2365	F	2	2	B708	04/03/91	10	835
08/24/91	2366	M	2	2	B708	04/03/91	10	835
08/16/91	2367	F	2	2	B708	04/03/91	10	835
08/16/91	2363	M	2	2	B708	04/03/91	10	835
08/16/91	2369	F	3	3	B708	04/03/91	10	835
08/16/91	2371	M	2	2	B708	04/03/91	10	835
08/24/91	2372	F	1	1	B708	04/03/91	10	835
08/12/91	2364	F	2	2	B708	04/03/91	10	835
04/04/91	9507	F	1	1	B709	10/25/90	13	835
04/04/91	9510	M	2	3	B709	10/25/90	13	835
04/04/91	9515	F	2	2	B709	10/25/90	13	835

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Bursitis score Right	Sow ID	Date of birth	No. born	Boar ID
07/19/91	2163	M	1	1	B709	03/22/91	10	839
08/12/91	2164	F	2	2	B709	03/22/91	10	839
07/19/91	2168	F	3	2	B709	03/22/91	10	839
08/12/91	2161	F	2	2	B709	03/22/91	10	839
04/04/91	9628	F	3	3	B710	11/02/90	10	835
04/04/91	9625	M	2	2	B710	11/02/90	10	835
04/19/91	9627	m	3	2	B710	11/02/90	10	835
08/24/91	2101	F	3	3	B710	03/20/91	13	839
08/12/91	2094	F	2	3	B710	03/20/91	13	839
08/12/91	2097	F	3	2	B710	03/20/91	13	839
08/12/91	2100	F	2	3	B710	03/20/91	13	839
04/19/91	9727	M	3	3	B711	11/12/90	8	785
05/10/91	1098	M	2	2	B712	12/15/90	7	835
05/10/91	1097	M	2	2	B712	12/15/90	7	835
05/10/91	1096	F	2	1	B712	12/15/90	7	835
05/10/91	1009	F	1	2	B713	12/08/90	11	839
05/10/91	1007	F	3	2	B713	12/08/90	11	839
05/10/91	1006	F	2	2	B713	12/08/90	11	839
05/10/91	1005	M	2	2	B713	12/08/90	11	839
05/24/91	1004	F	2	3	B713	12/08/90	11	839
05/03/91	1003	M	1	2	B713	12/08/90	11	839
05/03/91	1001	M	2	1	B713	12/08/90	11	839
05/10/91	1115	F	2	2	B714	12/20/90	7	839
05/10/91	1114	M	3	3	B714	12/20/90	7	839
05/24/91	1113	F	0	0	B714	12/20/90	7	839
05/10/91	1112	M	2	3	B714	12/20/90	7	839
05/24/91	1117	F	3	3	B714	12/20/90	7	839
06/06/91	1502	M	2	2	B715	01/16/91	9	785
06/06/91	1503	F	1	2	B715	01/16/91	9	785
06/06/91	1499	F	2	3	B715	01/16/91	9	785
06/06/91	1501	M	1	1	B715	01/16/91	9	785
06/06/91	9935	F	2	1	B716	11/30/90	10	839
04/19/91	9936	M	1	1	B716	11/30/90	10	839
05/10/91	9937	F	2	2	B716	11/30/90	10	839
05/10/91	9938	F	2	3	B716	11/30/90	10	839
05/10/91	9941	F	2	2	B716	11/30/90	10	839
05/10/91	9939	M	3	3	B716	11/30/90	10	839
05/03/91	9940	F	3	3	B716	11/30/90	10	839
04/19/91	9934	M	2	2	B716	11/30/90	10	839
05/10/91	1048	F	2	1	B717	12/11/90	14	835
05/10/91	1048	F	2	2	B717	12/11/90	14	835
05/10/91	1045	F	2	2	B717	12/11/90	14	835
05/10/91	1044	F	2	2	B717	12/11/90	14	835
05/10/91	1040	F	2	2	B717	12/11/90	14	835
05/10/91	1039	M	3	3	B717	12/11/90	14	835
05/03/91	1038	F	2	1	B717	12/11/90	14	835
05/03/91	1037	M	1	1	B717	12/11/90	14	835
05/10/91	1036	F	2	3	B717	12/11/90	14	835

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/03/91	1036	M	3	3	B717	12/11/90	14	835
04/19/91	9899	M	2	3	B718	11/25/90	4	785
05/03/91	9878	M	3	2	B719	11/23/90	11	785
05/03/91	9879	F	3	3	B719	11/23/90	11	785
05/10/91	9945	M	1	3	B720	12/04/90	12	839
05/03/91	9943	M	2	2	B720	12/04/90	12	839
05/24/91	9949	F	2	2	B720	12/04/90	12	839
05/03/91	9952	F	1	2	B720	12/04/90	12	839
05/03/91	9953	F	2	1	B720	12/04/90	12	839
04/19/91	9794	M	0	1	B721	11/17/90	10	835
04/04/91	9796	F	2	2	B721	11/17/90	10	835
04/19/91	9792	F	2	3	B721	11/17/90	10	835
03/01/91	9793	F	1	1	B721	11/17/90	10	835
08/12/91	2322	F	2	3	B721	04/02/91	8	716
08/12/91	2325	F	2	3	B721	04/02/91	8	716
05/10/91	9890	M	1	1	B722	11/25/90	10	785
05/03/91	9894	M	0	1	B722	11/25/90	10	785
05/10/91	9903	F	2	2	B723	11/26/90	3	785
06/06/91	1440	F	2	2	B724	01/12/91	10	785
05/31/91	1434	F	3	3	B724	01/12/91	10	785
05/31/91	1435	M	3	3	B724	01/12/91	10	785
06/06/91	1436	M	2	2	B724	01/12/91	10	785
05/31/91	1437	F	2	2	B724	01/12/91	10	785
06/06/91	1438	F	3	2	B724	01/12/91	10	785
05/31/91	1439	F	1	1	B724	01/12/91	10	785
06/06/91	1431	F	2	2	B724	01/12/91	10	785
05/24/91	1336	M	0	1	B725	01/09/91	5	785
06/06/91	1334	M	2	2	B725	01/09/91	5	785
06/06/91	1335	M	1	1	B725	01/09/91	5	785
05/24/91	1343	M	3	3	B726	01/09/91	10	835
06/06/91	1339	F	2	2	B726	01/09/91	10	835
05/31/91	1340	M	2	3	B726	01/09/91	10	835
05/31/91	1342	M	2	2	B726	01/09/91	10	835
05/31/91	1344	M	2	2	B726	01/09/91	10	835
05/31/91	1346	M	2	2	B726	01/09/91	10	835
05/31/91	1347	M	2	2	B726	01/09/91	10	835
05/24/91	1328	M	2	2	B727	01/09/91	8	835
05/24/91	1329	F	2	3	B727	01/09/91	8	835
05/31/91	1403	M	1	1	B728	01/10/91	8	716
05/31/91	1356	M	2	2	B729	01/09/91	9	839
05/31/91	1357	F	2	2	B729	01/09/91	9	839
05/31/91	1350	F	2	2	B729	01/09/91	9	839
06/06/91	1352	M	2	1	B729	01/09/91	9	839
05/31/91	1354	F	2	2	B729	01/09/91	9	839
05/31/91	1355	F	3	3	B729	01/09/91	9	839
05/31/91	1349	F	2	2	B729	01/09/91	9	839
05/24/91	1358	F	1	1	B730	01/06/91	13	716
05/24/91	1360	M	2	1	B730	01/06/91	13	716

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/31/91	1361	M	1	1	B730	01/06/91	13	716
05/31/91	1362	M	2	2	B730	01/06/91	13	716
05/31/91	1364	F	1	1	B730	01/06/91	13	716
05/24/91	1369	F	1	0	B730	01/06/91	13	716
05/24/91	1467	F	1	2	B731	01/13/91	10	785
06/06/91	1469	M	2	2	B731	01/13/91	10	785
06/06/91	1470	M	2	3	B731	01/13/91	10	785
06/06/91	1471	F	2	2	B731	01/13/91	10	785
07/11/91	1472	F	2	2	B731	01/13/91	10	785
05/24/91	1465	M	2	2	B731	01/13/91	10	785
06/06/91	1466	F	2	2	B731	01/13/91	10	785
05/24/91	1479	F	1	2	B732	01/13/91	11	716
05/24/91	1476	M	2	2	B732	01/13/91	11	716
06/06/91	1477	F	1	2	B732	01/13/91	11	716
06/06/91	1483	M	2	2	B732	01/13/91	11	716
06/06/91	1484	F	3	2	B732	01/13/91	11	716
06/06/91	1478	F	1	1	B732	01/13/91	11	716
06/06/91	1324	F	2	3	B733	01/09/91	11	785
07/11/91	1319	F	2	2	B733	01/09/91	11	785
05/24/91	1323	F	2	2	B733	01/09/91	11	785
05/24/91	1423	M	1	1	B734	01/11/91	9	839
06/06/91	1426	F	2	2	B734	01/11/91	9	839
05/31/91	1428	F	2	2	B734	01/11/91	9	839
06/06/91	1454	M	3	2	B735	01/12/91	12	785
06/06/91	1457	F	2	2	B735	01/12/91	12	785
06/06/91	1462	F	1	2	B735	01/12/91	12	785
05/24/91	1463	M	2	2	B735	01/12/91	12	785
07/05/91	1464	M	3	2	B735	01/12/91	12	785
05/24/91	1460	M	1	2	B735	01/12/91	12	785
06/06/91	1460	M	1	2	B735	01/12/91	12	785
05/31/91	1461	F	2	2	B735	01/12/91	12	785
08/16/91	1852	F	2	1	B736	03/01/91	13	839
07/19/91	1853	F	2	2	B736	03/01/91	13	839
07/05/91	1856	M	2	2	B736	03/01/91	13	839
07/05/91	1859	F	3	3	B736	03/01/91	13	839
08/16/91	1860	F	1	1	B736	03/01/91	13	839
07/05/91	1649	M	2	2	B737	02/07/91	9	839
07/05/91	1642	M	3	2	B737	02/07/91	9	839
07/11/91	1645	M	2	2	B737	02/07/91	9	839
07/11/91	1647	F	2	2	B737	02/07/91	9	839
07/05/91	1648	F	2	2	B737	02/07/91	9	839
07/19/91	1762	F	0	2	B739	02/26/91	10	839
07/19/91	1764	F	2	2	B739	02/26/91	10	839
06/06/91	1550	F	2	3	B740	01/21/91	5	785
08/16/91	1888	F	2	1	B741	03/06/91	10	839
08/24/91	1995	F	3	2	B742	03/17/91	10	370
08/12/91	1996	M	2	2	B742	03/17/91	10	370
08/12/91	1997	F	2	2	B742	03/17/91	10	370

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
08/12/91	1998	M	1	1	B742	03/17/91	10	370
07/26/91	1999	M	1	2	B742	03/17/91	10	370
07/26/91	1990	M	2	2	B742	03/17/91	10	370
08/12/91	2116	F	2	2	B743	03/20/91	9	785
08/12/91	2118	F	3	3	B743	03/20/91	9	785
08/12/91	2119	M	2	2	B743	03/20/91	9	785
08/12/91	2123	F	3	2	B743	03/20/91	9	785
08/12/91	2134	F	2	2	B744	03/21/91	13	785
08/12/91	2136	F	2	3	B744	03/21/91	13	785
08/12/91	2128	F	1	1	B744	03/21/91	13	785
08/12/91	2130	F	2	2	B744	03/21/91	13	785
08/16/91	2131	F	2	1	B744	03/21/91	13	785
08/12/91	2132	F	2	2	B744	03/21/91	13	785
08/12/91	2133	F	2	2	B744	03/21/91	13	785
08/16/91	2278	F	2	2	B745	03/27/91	9	839
08/12/91	2280	F	2	1	B745	03/27/91	9	839
07/19/91	2282	M	3	2	B745	03/27/91	9	839
08/12/91	2283	F	2	3	B745	03/27/91	9	839
08/16/91	2297	F	1	1	B747	03/30/91	14	839
08/24/91	2305	F	2	2	B747	03/30/91	14	839
08/24/91	2307	F	1	1	B747	03/30/91	14	839
07/26/91	2294	F	2	3	B747	03/30/91	14	839
08/24/91	2298	F	1	1	B747	03/30/91	14	839
08/16/91	2303	F	2	2	B747	03/30/91	14	839
08/24/91	2304	M	2	1	B747	03/30/91	14	839
08/24/91	2291	F	3	2	B748	03/27/91	8	785
08/12/91	2285	M	2	3	B748	03/27/91	8	785
08/12/91	2286	F	5	2	B748	03/27/91	8	785
08/16/91	2287	F	2	2	B748	03/27/91	8	785
08/12/91	2288	M	2	3	B748	03/27/91	8	785
08/12/91	2290	F	3	3	B748	03/27/91	8	785
08/12/91	2230	M	2	2	B749	03/24/91	11	839
08/12/91	2230	M	2	2	B749	03/24/91	11	839
08/24/91	2231	M	1	2	B749	03/24/91	11	839
08/16/91	2232	M	2	3	B749	03/24/91	11	839
08/24/91	2225	F	1	1	B749	03/24/91	11	839
08/16/91	2234	M	3	3	B749	03/24/91	11	839
08/16/91	2253	M	2	3	B750	03/26/91	9	370
08/24/91	2257	M	1	1	B750	03/26/91	9	370
08/16/91	2256	M	2	2	B750	03/26/91	9	370
07/26/91	2257	M	3	3	B750	03/26/91	9	370
08/12/91	2204	F	3	3	B751	03/24/91	12	835
08/12/91	2207	F	2	1	B751	03/24/91	12	835
07/19/91	2210	M	3	3	B751	03/24/91	12	835
07/26/91	2000	M	3	3	B752	03/17/91	10	785
08/12/91	2001	M	3	2	B752	03/17/91	10	785
07/26/91	2009	F	2	2	B752	03/17/91	10	785
08/12/91	2003	F	3	3	B752	03/17/91	10	785

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
08/12/91	2005	F	2	2	B752	03/17/91	10	785
08/12/91	2007	F	2	3	B752	03/17/91	10	785
07/26/91	2213	F	2	2	B753	03/24/91	13	785
08/16/91	2223	F	2	2	B753	03/24/91	13	785
08/16/91	2215	F	2	2	B753	03/24/91	13	785
08/16/91	2218	M	2	3	B753	03/24/91	13	785
08/16/91	2220	M	3	3	B753	03/24/91	13	785
08/12/91	2222	F	2	2	B753	03/24/91	13	785
08/24/91	7194	M	2	2	B754	03/24/91	7	785
08/24/91	7195	M	2	2	B754	03/24/91	7	785
08/12/91	7196	F	2	2	B754	03/24/91	7	785
08/12/91	7197	F	2	2	B754	03/24/91	7	785
07/26/91	2027	M	2	2	B755	03/18/91	9	785
07/26/91	1946	M	3	2	B756	03/11/91	7	375
07/19/91	1959	F	2	2	B757	03/13/91	11	370
07/26/91	1960	M	3	3	B757	03/13/91	11	370
08/12/91	1953	F	3	3	B757	03/13/91	11	370
08/12/91	1954	F	3	2	B757	03/13/91	11	370
08/12/91	2115	F	2	2	B759	03/20/91	9	785
08/12/91	2109	M	3	3	B759	03/20/91	9	785
07/26/91	2110	F	2	2	B759	03/20/91	9	785
07/19/91	2111	F	2	2	B759	03/20/91	9	785
08/12/91	2114	F	2	2	B759	03/20/91	9	785
03/01/91	9483	M	2	3	B943	10/12/90	5	716
04/04/91	9530	F	3	3	B944	10/25/90	7	716
03/08/91	9533	M	3	1	B944	10/25/90	7	716
03/01/91	9291	M	1	0	B946	10/05/90	10	716
03/01/91	9292	M	2	2	B946	10/05/90	10	716
03/01/91	9294	M	5	3	B946	10/05/90	10	716
03/01/91	9296	M	1	2	B946	10/05/90	10	716
03/08/91	9299	F	0	0	B946	10/05/90	10	716
03/08/91	9287	F	1	0	B947	10/05/90	7	839
03/01/91	9289	F	1	1	B947	10/05/90	7	839
02/22/91	9213	F	2	1	B948	09/26/90	12	839
03/08/91	9216	F	1	1	B948	09/26/90	12	839
02/22/91	9219	F	2	3	B948	09/26/90	12	839
02/22/91	9217	M	1	2	B948	09/26/90	12	839
02/22/91	9218	F	3	3	B948	09/26/90	12	839
06/06/91	1410	F	1	1	B950	01/11/91	14	839
05/31/91	1411	M	2	2	B950	01/11/91	14	839
05/31/91	1414	F	1	1	B950	01/11/91	14	839
06/06/91	1414	F	1	2	B950	01/11/91	14	839
06/06/91	1418	M	2	2	B950	01/11/91	14	839
06/06/91	1420	M	1	0	B950	01/11/91	14	839
04/19/91	9882	M	2	2	B951	11/24/90	6	839
05/03/91	9884	F	2	2	B951	11/24/90	6	839
04/19/91	9887	F	2	3	B951	11/24/90	6	839
04/04/91	9886	M	3	3	B951	11/24/90	6	839

Appendix 8.1 (Contd.)

Date of Sample	Piglet ID	Sex	Bursitis score Left	Right	Sow ID	Date of birth	No. born	Boar ID
05/24/91	1162	F	2	2	B952	12/27/90	10	839
05/31/91	1163	M	2	2	B952	12/27/90	10	839
05/10/91	1164	F	2	1	B952	12/27/90	10	839
05/24/91	1165	F	2	2	B952	12/27/90	10	839
05/31/91	1168	F	3	3	B952	12/27/90	10	839
05/31/91	1170	F	2	1	B952	12/27/90	10	839
07/19/91	1773	F	2	1	B955	02/26/91	12	375
07/11/91	1774	M	2	3	B955	02/26/91	12	375
07/19/91	1775	M	2	2	B955	02/26/91	12	375
07/19/91	1776	F	2	2	B955	02/26/91	12	375
08/12/91	1988	F	2	2	B956	03/17/91	7	839
08/12/91	2244	M	2	2	B958	03/26/91	9	375
07/26/91	2245	F	2	1	B958	03/26/91	9	375
08/12/91	2246	M	2	2	B958	03/26/91	9	375
08/16/91	2249	M	3	3	B958	03/26/91	9	375
08/24/91	2249	F	3	2	B958	03/26/91	9	375
08/24/91	2252	F	2	1	B958	03/26/91	9	375
08/12/91	2250	M	1	2	B958	03/26/91	9	375
08/16/91	2251	F	1	2	B958	03/26/91	9	375
08/24/91	2334	F	1	1	B959	04/02/91	11	375
08/24/91	2335	M	1	1	B959	04/02/91	11	375
08/24/91	2338	M	1	1	B959	04/02/91	11	375
08/24/91	2329	M	1	1	B959	04/02/91	11	375
08/16/91	2331	F	2	2	B959	04/02/91	11	375
08/24/91	2332	M	2	1	B959	04/02/91	11	375
08/24/91	2333	F	2	1	B959	04/02/91	11	375
07/19/91	1758	F	1	2	B960	02/20/91	3	370

Appendix 8.2: The farm ID, sex and mean bursitis score of each leg from coloured pigs.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample
GA	F	0	0	05/15/89	H2	F	0	0	05/15/89
GA	F	0	0	05/15/89	H2	M	0	0	05/15/89
GA	M	0	1	05/15/89	H2	F	0	1	05/15/89
GA	F	1	0	05/15/89	H2	M	0	0	05/15/89
GA	M	0	0	05/15/89	H2	F	0	0	05/15/89
GA	M	0	0	05/15/89	H2	M	0	0	05/15/89
GA	M	0	0	05/15/89	H2	F	0	0	05/15/89
GA	F	0	0	05/15/89	H2	F	0	0	05/15/89
GA	F	0	0	05/15/89	H2	M	0	0	05/15/89
GA	M	0	0	05/15/89	H2	M	0	0	05/15/89
GA	F	0	0	05/15/89	H2	F	0	0	05/15/89
GA	F	0	1	05/15/89	H2	M	0	0	05/15/89
GA	F	0	1	05/15/89	H2	F	0	0	05/15/89
GA	M	0	0	05/15/89	H2	F	0	0	05/15/89
GA	F	1	1	05/15/89	H2	M	0	1	05/15/89
GA	M	0	0	05/15/89	H2	M	0	0	05/15/89
GA	F	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	1	1	05/15/89	H2	F	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	05/15/89
H2	M	0	1	05/15/89	H2	F	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	M	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	05/15/89

Appendix 8.2 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample
H2	F	0	0	05/15/89	H2	M	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	M	0	0	05/15/89	H2	F	0	0	05/15/89
H2	F	0	0	05/15/89	H2	F	0	0	06/05/89
J2	M	2	2	05/15/89	H2	M	0	0	05/15/89
J2	M	0	0	05/15/89	J2	M	2	2	05/15/89
J2	M	1	0	05/15/89	J4	F	1	1	05/15/89
J2	M	1	0	05/15/89	J4	F	1	1	05/15/89
J2	M	1	2	05/15/89	J4	F	2	1	05/15/89
J2	M	0	1	05/15/89	J4	F	1	3	05/15/89
J2	M	2	1	05/15/89	J4	F	1	1	05/15/89
J2	M	0	0	05/15/89	J4	F	3	3	05/15/89
J2	M	1	1	05/15/89	J4	F	0	0	05/15/89
J2	M	2	2	05/15/89	J4	F	0	0	05/15/89
J2	M	0	0	05/15/89	J4	F	0	0	05/15/89
J2	M	2	3	05/15/89	J4	F	1	2	05/15/89
J2	M	0	1	05/15/89	J4	F	2	2	05/15/89
J2	M	0	2	05/15/89	J4	F	2	3	05/15/89
J2	M	1	2	05/15/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	2	2	05/15/89
H2	F	0	0	06/05/89	J4	F	0	1	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	1	0	05/15/89
H2	F	3	3	06/05/89	J4	F	0	2	05/15/89
H2	F	0	0	06/05/89	J4	F	0	1	05/15/89
H2	F	0	0	06/05/89	J4	F	2	1	05/15/89
H2	F	0	0	06/05/89	J4	F	2	2	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	1	1	05/15/89
H2	F	0	0	06/05/89	J4	F	0	0	05/15/89
H2	F	0	0	06/05/89	J4	F	0	1	05/15/89
H2	F	0	0	06/05/89	J4	F	1	0	05/15/89
H2	F	0	0	06/05/89	J4	F	1	2	05/15/89
H2	F	0	0	06/05/89	J2	M	1	1	05/15/89
H2	F	0	0	06/05/89	J2	M	0	0	05/15/89
H2	F	0	0	06/05/89	J2	M	0	0	05/15/89
H2	F	0	0	06/05/89	J2	M	0	2	05/15/89
H2	F	0	0	06/05/89	J2	M	1	1	05/15/89
H2	F	0	0	06/05/89	J2	M	2	1	05/15/89
H2	F	0	0	06/05/89	J2	M	2	2	05/15/89
H2	F	0	0	06/05/89	J2	M	0	1	05/15/89
H2	F	0	0	06/05/89	J2	M	0	0	05/15/89
H2	F	0	0	06/05/89	J2	M	4	1	05/15/89
H2	F	0	0	06/05/89	J2	M	1	1	05/15/89

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Right	Date of sample	Farm ID	Sex	Bursitis score Left	Right	Date of sample
H2	F	0	0	06/05/89	J2	M	0	2	05/15/89
H2	F	0	0	06/05/89	J2	M	1	0	05/15/89
H2	F	0	0	06/05/89	J2	M	0	1	05/15/89
H2	F	0	0	06/05/89	J2	M	1	1	05/15/89
H2	F	0	0	06/05/89	J2	M	1	1	05/15/89
H2	F	0	0	06/05/89	J2	M	1	1	05/15/89
H2	F	0	0	06/05/89	J2	M	1	0	05/15/89
H2	F	0	0	06/05/89	J2	F	0	0	05/15/89
J2	F	3	3	05/15/89	J5	F	2	3	06/05/89
H2	F	0	0	06/05/89	J5	F	1	3	06/05/89
H2	F	0	0	06/05/89	J5	F	1	2	06/05/89
H2	F	0	0	06/05/89	J5	F	0	1	06/05/89
H2	F	0	0	06/05/89	J5	F	1	1	06/05/89
H2	F	0	0	06/05/89	J5	F	0	0	06/05/89
H2	F	1	0	06/05/89	J5	F	2	3	06/05/89
H2	F	0	1	06/05/89	J5	F	3	3	06/05/89
H2	F	0	0	06/05/89	J5	F	1	1	06/05/89
H2	F	0	0	06/05/89	J5	F	0	0	06/05/89
H2	F	0	0	06/05/89	J5	F	1	3	06/05/89
H2	F	0	0	06/05/89	J5	F	1	0	06/05/89
H2	F	0	0	06/05/89	J5	F	3	3	06/05/89
H2	F	0	0	06/05/89	J5	F	1	1	06/05/89
H2	F	0	0	06/05/89	J5	F	2	2	06/05/89
H2	F	0	0	06/05/89	J5	F	2	1	06/05/89
H2	F	0	0	06/05/89	J5	F	2	2	06/05/89
H2	F	0	0	06/05/89	J5	F	1	1	06/05/89
H2	F	0	0	06/05/89	J5	F	1	2	06/05/89
H2	F	0	0	06/05/89	J5	F	3	2	06/05/89
H2	F	0	0	06/05/89	J5	F	1	0	06/05/89
H2	F	0	0	06/05/89	J5	F	2	2	06/05/89
H2	F	0	0	06/05/89	J5	F	0	0	06/05/89
H2	F	1	1	06/05/89	J5	F	2	1	06/05/89
H2	F	0	0	06/05/89	J5	F	2	2	06/05/89
H2	F	0	0	06/05/89	J5	F	0	0	06/05/89
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
H2	F	0	0	06/05/89	BC	M	0	0	02/28/90
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
H2	F	0	0	06/05/89	BC	F	1	0	02/28/90
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
H2	F	0	0	06/05/89	BC	F	0	0	02/28/90
J2	F	2	1	06/05/89	BC	F	0	0	02/28/90
J2	F	0	0	06/05/89	BC	F	0	0	02/28/90
J2	F	1	1	06/05/89	BC	M	0	0	02/28/90
J2	F	0	1	06/05/89	BC	M	0	0	02/28/90
J2	F	3	3	06/05/89	BC	F	0	0	02/28/90

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample
J2	F	0	0	06/05/89	BC	M	0	0	02/28/90
J2	F	2	2	06/05/89	BC	F	0	0	02/28/90
J2	F	1	1	06/05/89	BC	F	0	0	02/28/90
J5	F	0	0	06/05/89	BC	M	0	0	02/28/90
J5	F	2	1	06/05/89	BC	F	0	0	02/28/90
J5	F	1	1	06/05/89	BC	F	0	0	02/28/90
J5	F	2	0	06/05/89	BC	F	0	0	02/28/90
J5	F	0	1	06/05/89	BC	F	0	0	02/28/90
J5	F	1	0	06/05/89	BC	F	0	0	02/28/90
J5	F	1	1	06/05/89	BC	F	0	0	02/28/90
J5	F	1	2	06/05/89	BC	F	0	0	02/28/90
J5	F	1	1	06/05/89	BC	F	0	0	02/28/90
J5	F	2	1	06/05/89	BC	F	0	0	02/28/90
J5	F	1	1	06/05/89	BC	M	0	0	02/28/90
J5	F	1	1	06/05/89	BC	F	0	0	02/28/90
J5	F	2	1	06/05/89	BC	F	0	0	02/28/90
BC	M	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	M	0	0	02/28/90
BC	M	0	0	02/28/90	BC	M	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	M	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	M	0	0	02/28/90	BC	M	0	0	02/28/90
BC	F	0	0	02/28/90	BC	M	0	0	02/28/90
BC	M	0	0	02/28/90	BC	M	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	M	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	M	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	M	0	0	02/28/90	BC	M	0	0	02/28/90
BC	M	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	M	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	M	0	0	02/28/90
BC	M	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	BC	F	0	0	02/28/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Right	Date of sample	Farm ID	Sex	Bursitis score Left	Right	Date of sample
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	M	0	0	02/28/90	JG	M	0	0	07/31/90
BC	M	0	0	02/28/90	JG	F	1	1	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	M	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	F	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
BC	F	0	0	02/28/90	JG	M	0	1	07/31/90
BC	F	0	0	02/28/90	JG	M	0	0	07/31/90
JG	M	0	1	07/31/90	DI	F	1	1	12/17/90
JG	M	0	0	07/31/90	DI	F	1	1	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	M	0	1	07/31/90	DI	M	0	1	12/17/90
JG	M	0	0	07/31/90	DI	F	0	0	12/17/90
JG	F	0	0	07/31/90	DI	F	0	0	12/17/90
JG	M	0	0	07/31/90	DI	F	0	0	12/17/90
JG	F	0	0	07/31/90	DI	F	0	0	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	F	0	0	07/31/90	DI	M	1	1	12/17/90
JG	F	0	0	07/31/90	DI	M	0	0	12/17/90
JG	F	0	0	07/31/90	DI	F	0	0	12/17/90
JG	F	0	0	07/31/90	DI	M	1	0	12/17/90
JG	F	0	0	07/31/90	DI	F	1	1	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	F	2	1	07/31/90	DI	M	0	0	12/17/90
JG	F	1	0	07/31/90	DI	M	0	0	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	M	0	0	07/31/90	DI	F	1	0	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	F	0	0	07/31/90	DI	M	1	1	12/17/90
JG	M	0	0	07/31/90	DI	F	0	0	12/17/90
JG	F	0	0	07/31/90	DI	F	0	0	12/17/90
JG	M	0	0	07/31/90	DI	F	1	0	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	M	0	1	07/31/90	DI	M	0	0	12/17/90
JG	M	0	0	07/31/90	DI	F	1	1	12/17/90
JG	M	0	0	07/31/90	DI	F	1	1	12/17/90

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Right	Date of sample	Farm ID	Sex	Bursitis score Left	Right	Date of sample
JG	F	0	0	07/31/90	DI	M	0	0	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
JG	F	0	0	07/31/90	DI	M	0	0	12/17/90
JG	M	0	0	07/31/90	DI	M	0	0	12/17/90
P2	F	0	0	12/24/90	DI	M	0	0	12/17/90
P2	F	2	2	12/24/90	DI	F	1	1	12/17/90
P2	F	0	1	12/24/90	DI	M	1	1	12/17/90
P2	F	3	1	12/24/90	DI	F	0	0	12/17/90
P2	M	1	0	12/24/90	DI	F	0	0	12/17/90
P2	F	1	0	12/24/90	DI	M	1	1	12/17/90
P2	M	1	0	12/24/90	DI	M	1	1	12/17/90
P2	M	1	0	12/24/90	DI	M	1	1	12/17/90
P2	F	0	0	12/24/90	DI	F	0	0	12/17/90
P2	F	3	2	12/24/90	PI	F	1	1	06/18/91
P2	M	0	0	12/24/90	PI	M	2	2	06/18/91
P2	F	0	0	12/24/90	PI	F	2	2	06/18/91
P2	M	0	0	12/24/90	PI	M	1	2	06/18/91
P2	M	2	1	12/24/90	PI	M	0	0	06/18/91
P2	M	0	0	12/24/90	PI	M	2	2	06/18/91
P2	M	1	1	12/24/90	PI	M	1	1	06/18/91
Z7	F	1	2	06/18/91	PF	M	0	0	06/18/91
Z7	F	1	1	06/18/91	PF	F	0	0	06/18/91
Z7	M	0	1	06/18/91	PF	F	0	0	06/18/91
Z7	F	3	1	06/18/91	PF	F	0	0	06/18/91
Z7	F	0	1	06/18/91	PF	F	0	0	06/18/91
Z7	M	1	1	06/18/91	PF	F	0	0	06/18/91
Z7	F	1	2	06/18/91	PF	M	0	0	06/18/91
Z7	M	0	0	06/18/91	PF	M	0	0	06/18/91
Z7	F	1	1	06/18/91	PF	M	0	0	06/18/91
Z7	M	0	0	06/18/91	PF	M	0	0	06/18/91
Z7	M	1	1	06/18/91	PF	F	0	0	06/18/91
Z7	F	1	2	06/18/91	PF	F	0	0	06/18/91
Z7	F	0	0	06/18/91	PF	F	0	0	06/18/91
Z7	F	2	2	06/18/91	PF	F	0	0	06/18/91
Z7	F	1	1	06/18/91	PF	F	0	0	06/18/91
Z7	F	1	0	06/18/91	PF	M	0	0	06/18/91
Z7	F	1	1	06/18/91	PF	F	0	0	06/18/91
Z7	F	5	5	06/18/91	PF	M	0	0	06/18/91
Z7	M	1	1	06/18/91	PF	F	0	0	06/18/91
PF	M	0	0	06/18/91	JJ	M	0	1	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	1	07/31/91
PF	F	0	0	06/18/91	JJ	F	2	1	07/31/91
PF	M	0	0	06/18/91	JJ	M	1	3	07/31/91
PF	F	0	0	06/18/91	JJ	M	1	1	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	0	0	06/18/91	JJ	F	0	1	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	1	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	0	07/31/91

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Right	Date of sample	Farm ID	Sex	Bursitis score Left	Right	Date of sample
PF	F	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	M	0	0	06/18/91	JJ	M	1	0	07/31/91
PF	F	0	0	06/18/91	JJ	M	2	0	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	M	0	0	06/18/91	JJ	M	1	2	07/31/91
PF	F	0	0	06/18/91	JJ	M	1	0	07/31/91
PF	F	0	0	06/18/91	JJ	M	2	3	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	2	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	0	0	06/18/91	JJ	F	1	1	07/31/91
PF	M	0	0	06/18/91	JJ	M	0	0	07/31/91
PF	F	1	0	06/18/91	JJ	F	2	2	07/16/91
2J	F	0	1	07/16/91	JJ	F	2	1	07/16/91
2J	F	0	0	07/16/91	JJ	F	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	F	0	0	07/16/91
2J	F	1	1	07/16/91	JJ	F	0	0	07/16/91
2J	F	0	0	07/16/91	2J	M	2	1	07/16/91
2J	F	1	0	07/16/91	JJ	F	2	0	07/16/91
2J	F	0	0	07/16/91	2J	M	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	F	0	0	07/16/91
2J	F	0	1	07/16/91	JJ	F	1	1	07/16/91
2J	F	2	0	07/16/91	JJ	F	0	0	07/16/91
2J	F	0	0	07/16/91	2J	M	3	3	07/16/91
2J	F	1	0	07/16/91	JJ	M	0	1	07/16/91
2J	F	1	0	07/16/91	PF	F	0	0	07/16/91
2J	F	1	2	07/16/91	PF	F	0	0	07/16/91
2J	F	0	1	07/16/91	PF	F	0	0	07/16/91
2J	F	0	0	07/16/91	PF	M	0	0	07/16/91
2J	F	2	1	07/16/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	M	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	1	1	07/31/91	PF	M	0	0	07/16/91
2J	F	1	1	07/31/91	PF	M	0	0	07/16/91
2J	F	1	1	07/31/91	PF	F	0	0	07/16/91
2J	F	2	1	07/31/91	PF	M	0	0	07/16/91
2J	F	1	0	07/31/91	PF	F	0	0	07/16/91
2J	F	2	1	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Right	Date of sample	Farm ID	Sex	Bursitis score Left	Right	Date of sample
2J	F	1	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	1	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	1	07/31/91	PF	F	0	0	07/16/91
2J	F	2	2	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	1	1	07/31/91	PF	M	0	0	07/16/91
2J	F	1	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	1	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	1	07/31/91	PF	F	0	0	07/16/91
2J	F	1	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	1	1	07/31/91	PF	M	0	0	07/16/91
2J	F	2	1	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	M	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	3	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	1	1	07/31/91	PF	F	0	0	07/16/91
2J	F	1	1	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	1	07/31/91	PF	M	0	0	07/16/91
2J	F	1	1	07/31/91	PF	F	0	0	07/16/91
2J	F	3	1	07/31/91	PF	F	0	0	07/16/91
2J	F	1	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	2	1	07/31/91	PF	F	0	0	07/16/91
2J	M	3	3	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	F	0	0	07/16/91
2J	M	1	1	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	1	0	07/31/91	PF	F	0	0	07/16/91
2J	M	0	2	07/31/91	PF	F	0	0	07/16/91
2J	F	0	0	07/31/91	PF	M	0	0	07/16/91
2J	F	1	1	07/31/91	PF	F	0	0	07/16/91
2J	F	2	1	07/31/91	PF	M	0	0	07/16/91
PF	F	0	0	07/16/91	2J	F	0	1	07/16/91
PF	F	0	0	07/16/91	2J	F	0	0	07/16/91
PF	F	0	0	07/16/91	2J	F	0	0	07/16/91
PF	M	0	0	07/16/91	2J	F	1	1	07/16/91

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample
PF	F	0	0	07/16/91	2J	F	0	0	07/16/91
PF	M	0	0	07/16/91	2J	F	1	0	07/16/91
PF	F	0	0	07/16/91	2J	F	0	0	07/16/91
PF	M	0	0	07/16/91	2J	F	0	0	07/16/91
PF	M	0	0	07/16/91	2J	F	0	1	07/16/91
PF	F	0	0	07/16/91	2J	F	2	0	07/16/91
PF	M	0	0	07/16/91	2J	F	0	0	07/16/91
PF	M	0	0	07/16/91	2J	F	1	0	07/16/91
2J	F	1	0	07/16/91	JJ	F	1	0	07/16/91
2J	F	1	2	07/16/91	JJ	F	2	2	07/16/91
2J	F	0	1	07/16/91	JJ	F	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	2	07/16/91	JJ	M	4	4	07/16/91
2J	F	0	0	07/16/91	JJ	M	1	1	07/16/91
2J	F	4	4	07/16/91	JJ	M	2	1	07/16/91
2J	F	0	0	07/16/91	JJ	M	3	1	07/16/91
2J	F	0	1	07/16/91	JJ	M	0	0	07/16/91
2J	M	1	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	1	1	07/16/91
2J	F	1	1	07/16/91	JJ	M	1	1	07/16/91
2J	F	0	0	07/16/91	JJ	M	2	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	1	07/16/91	JJ	M	1	1	07/16/91
2J	F	2	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	1	07/16/91	JJ	M	3	1	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	1	07/16/91
2J	F	0	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	1	1	07/16/91
2J	F	1	4	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	1	0	07/16/91
2J	F	0	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	0	07/16/91	JJ	M	0	1	07/16/91
2J	F	2	2	07/16/91	JJ	M	0	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	2	1	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	0	07/16/91
2J	F	3	2	07/16/91	JJ	M	2	1	07/16/91
2J	F	0	2	07/16/91	JJ	M	2	0	07/16/91
2J	F	0	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	2	2	07/16/91	JJ	M	2	1	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	0	07/16/91	JJ	M	2	1	07/16/91
2J	F	2	2	07/16/91	JJ	M	0	0	07/16/91
2J	F	2	1	07/16/91	JJ	M	0	0	07/16/91
2J	F	1	0	07/16/91	JJ	M	1	2	07/16/91

Appendix 8.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Date of sample
2J	F	0	0	07/16/91	JJ	M	2	2	07/16/91
2J	F	0	0	07/16/91	JJ	M	1	0	07/16/91
2J	F	0	0	07/16/91	JJ	M	1	2	07/16/91
2J	F	0	1	07/16/91	JJ	M	3	3	07/16/91
2J	F	0	0	07/16/91	JJ	M	0	1	07/16/91
PF	M	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	M	0	0	07/16/91	JJ	M	1	0	07/16/91
PF	F	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	M	0	0	07/16/91	JJ	M	1	0	07/16/91
PF	F	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	M	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	M	0	0	07/16/91	JJ	M	1	1	07/16/91
PF	F	0	0	07/16/91	JJ	M	1	2	07/16/91
PF	M	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	F	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	F	0	0	07/16/91	JJ	M	0	1	07/16/91
PF	M	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	F	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	M	0	0	07/16/91	JJ	M	1	1	07/16/91
PF	F	0	0	07/16/91	JJ	M	0	0	07/16/91
PF	F	0	0	07/16/91	JJ	M	1	2	07/16/91
JJ	M	0	0	07/16/91	JJ	M	1	1	07/16/91
JJ	M	1	2	07/16/91	JJ	M	0	0	07/16/91
JJ	M	0	0	07/16/91	JJ	M	0	1	07/16/91
JJ	M	1	0	07/16/91	JJ	M	2	0	07/16/91

Appendix 9.1 Coloured Pigs: The farm ID, sex, bursitis score of left and right leg and skin thickness of each leg in mm.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
J2	F	0	0	2.0	2.0	J2	F	0	0	5.0	6.0
J2	F	0	0	2.0	3.0	J2	F	0	0	5.0	6.0
J2	F	0	0	2.0	3.0	J2	F	0	0	5.0	6.0
J2	F	0	0	3.0	3.0	J2	F	0	0	5.0	6.0
J2	F	0	0	3.0	3.0	J2	F	0	0	6.0	5.0
J2	F	0	0	3.0	3.0	J2	F	0	0	6.0	5.0
J2	F	0	0	3.5	2.5	J2	F	0	0	5.0	6.5
J2	F	0	0	3.5	3.0	J2	F	0	0	6.0	5.5
J2	F	0	0	3.0	4.0	J2	F	0	0	6.0	6.0
J2	F	0	0	3.5	3.5	J2	F	0	0	7.0	6.0
J2	F	0	0	3.5	3.5	J2	F	0	0	7.0	7.0
J2	F	0	0	3.5	3.5	J2	F	0	0	7.0	7.0
J2	F	0	0	3.5	3.5	J2	F	0	0	7.0	7.0
J2	F	0	0	3.5	4.0	J2	F	0	0	7.0	7.0
J2	F	0	0	4.0	3.5	PF	F	0	0	2.0	3.0
J2	F	0	0	4.0	3.5	PF	F	0	0	3.0	4.0
J2	F	0	0	3.5	4.5	PF	F	0	0	3.0	4.0
J2	F	0	0	3.5	4.5	PF	F	0	0	4.0	3.0
J2	F	0	0	4.0	4.0	PF	F	0	0	4.0	3.0
J2	F	0	0	4.0	4.0	PF	F	0	0	3.5	4.0
J2	F	0	0	4.0	4.0	PF	F	0	0	3.5	4.0
J2	F	0	0	4.5	3.5	PF	F	0	0	3.5	4.0
J2	F	0	0	4.0	4.5	PF	F	0	0	3.0	5.0
J2	F	0	0	4.0	4.5	PF	F	0	0	4.0	4.0
J2	F	0	0	4.5	4.0	PF	F	0	0	4.0	5.0
J2	F	0	0	4.0	5.0	PF	F	0	0	5.0	4.0
J2	F	0	0	4.0	5.0	PF	F	0	0	5.0	4.0
J2	F	0	0	4.0	5.0	PF	F	0	0	5.0	4.0
J2	F	0	0	4.0	5.0	PF	F	0	0	5.0	5.0
J2	F	0	0	4.0	5.0	PF	F	0	0	5.0	5.0
J2	F	0	0	4.5	4.5	PF	F	0	0	6.0	5.0
J2	F	0	0	4.5	4.5	PF	F	0	0	6.0	5.0
J2	F	0	0	4.5	4.5	PF	M	0	0	3.0	3.0
J2	F	0	0	4.5	4.5	PF	M	0	0	3.0	4.0
J2	F	0	0	4.5	4.5	PF	M	0	0	4.0	4.0
J2	F	0	0	4.5	4.5	PF	M	0	0	4.0	5.0
J2	F	0	0	4.5	4.5	PF	M	0	0	5.0	5.0
J2	F	0	0	4.5	4.5	PF	M	0	0	5.0	5.0
J2	F	0	0	4.5	4.5	PF	M	0	0	5.0	5.0
J2	F	0	0	4.5	4.5	PF	M	0	0	5.0	5.0
J2	F	0	0	4.5	5.0	PF	M	0	0	5.0	6.0
J2	F	0	0	4.5	5.0	PF	M	0	0	7.0	6.0
J2	F	0	0	4.5	5.0	PF	M	0	0	7.0	6.0
J2	F	0	0	4.5	5.0	PF	M	0	0	8.0	8.0
J2	F	0	0	4.5	5.0	PF	F	0	1	2.0	2.0
J2	F	0	0	5.0	4.5	PF	F	0	1	4.0	4.0
J2	F	0	0	5.0	4.5	PF	F	0	1	4.0	4.0
J2	F	0	0	5.0	4.5	PF	F	0	1	4.0	5.0

Appendix 9.1(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
J2	F	0	0	5.0	4.5	PF	M	0	1	4.0	4.0
J2	F	0	0	4.5	5.5	PF	M	0	1	5.0	5.0
J2	F	0	0	4.5	5.5	PF	M	0	1	5.0	5.0
J2	F	0	0	5.0	5.0	PF	M	0	1	6.0	7.0
J2	F	0	0	5.0	5.0	PF	M	0	1	0.0	9.0
J2	F	0	0	5.0	5.0	J1	F	0	0	2.0	2.0
J2	F	0	0	5.0	5.0	J1	F	0	0	2.5	2.5
J2	F	0	0	5.0	5.0	J1	F	0	0	3.0	3.0
J2	F	0	0	5.0	5.5	J1	F	0	0	3.0	3.0
J1	F	0	0	3.5	3.5	J1	F	0	0	6.0	6.0
J1	F	0	0	3.5	3.5	J1	F	0	0	6.0	6.0
J1	F	0	0	3.5	4.0	J1	F	0	0	6.0	6.0
J1	F	0	0	3.5	4.0	J1	F	0	0	6.0	6.0
J1	F	0	0	3.5	4.0	J1	F	0	0	6.0	6.0
J1	F	0	0	3.5	4.0	J1	F	0	0	6.0	7.0
J1	F	0	0	4.0	3.5	J1	F	0	0	7.0	8.0
J1	F	0	0	4.0	3.5	J1	F	0	0	8.0	7.0
J1	F	0	0	4.0	3.5	J1	F	0	0	7.0	9.0
J1	F	0	0	3.5	4.5	J1	F	0	0	8.0	8.0
J1	F	0	0	3.5	4.5	J1	F	0	0	8.0	8.0
J1	F	0	0	3.5	4.5	J1	F	0	0	8.0	9.0
J1	F	0	0	4.0	4.0	J1	M	0	0	3.0	3.0
J1	F	0	0	4.0	4.0	J1	M	0	0	3.5	3.5
J1	F	0	0	4.0	4.0	J1	M	0	0	4.0	5.0
J1	F	0	0	4.0	4.0	J1	M	0	0	5.0	7.0
J1	F	0	0	4.0	4.0	J1	M	0	0	6.0	7.0
J1	F	0	0	4.0	4.0	J3	F	0	0	3.5	3.5
J1	F	0	0	4.0	4.0	J3	F	0	0	4.0	4.5
J1	F	0	0	4.5	3.5	J3	F	0	0	4.0	5.0
J1	F	0	0	3.5	5.0	J3	F	0	0	4.5	4.5
J1	F	0	0	4.0	4.5	J3	F	0	0	5.0	4.5
J1	F	0	0	4.0	4.5	J3	F	0	0	5.0	4.5
J1	F	0	0	4.0	4.5	J3	F	0	0	5.0	5.0
J1	F	0	0	4.5	4.0	J3	F	0	0	5.0	6.0
J1	F	0	0	4.5	4.0	J3	F	0	0	6.0	5.0
J1	F	0	0	4.0	5.0	J3	F	0	0	6.0	8.0
J1	F	0	0	4.0	5.0	J3	F	0	0	7.0	8.0
J1	F	0	0	4.0	5.0	J3	F	0	0	11.0	9.0
J1	F	0	0	4.5	4.5	J1	F	0	0	5.0	5.0
J1	F	0	0	4.5	4.5	J1	F	0	0	5.0	5.0
J1	F	0	0	5.0	4.0	J1	F	0	0	5.0	5.0
J1	F	0	0	4.5	5.0	J1	F	0	0	5.0	5.0
J1	F	0	0	4.5	5.0	J1	F	0	0	5.0	5.0
J1	F	0	0	4.5	5.0	J1	F	0	0	5.0	5.0
J1	F	0	0	5.0	4.5	J1	F	0	0	5.0	5.0
J1	F	0	0	5.0	4.5	J1	F	0	0	5.0	5.0
J1	F	0	0	5.0	4.5	J1	F	0	0	5.0	5.0
J1	F	0	0	5.0	4.5	J1	F	0	0	4.5	6.0
J1	F	0	0	4.0	6.0	J1	F	0	0	6.0	4.5

Appendix 9.1(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
J1	F	0	0	4.5	5.5	J1	F	0	0	5.0	6.0
J1	F	0	0	5.0	5.0	J1	F	0	0	5.0	6.0
J1	F	0	0	5.0	5.0	J1	F	0	0	5.0	6.0
J1	F	0	0	5.0	5.0	J1	F	0	0	5.0	6.0
J1	F	0	0	5.0	5.0	J1	F	0	0	5.0	6.0
J1	F	0	0	6.0	5.0	J1	F	0	0	6.0	6.0

Appendix 9.2: White Pigs: The farm ID, sex, mean bursitis score of left and right leg and skin thickness of left and right leg in mm.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
CD	F	0	0	4.0	3.5	CD	F	1	1	4.0	3.0
CD	F	0	0	5.0	5.0	CD	F	1	1	4.0	3.0
CD	F	0	0	6.0	6.0	CD	F	1	1	4.0	4.0
CD	M	0	0	3.0	2.5	CD	F	1	1	4.0	4.0
CD	M	0	0	4.0	4.0	CD	F	1	1	4.0	4.0
CD	M	0	0	4.0	4.0	CD	F	2	0	5.0	4.0
CD	M	0	0	4.5	4.5	CD	F	1	1	5.0	5.0
CD	M	0	0	9.0	8.0	CD	F	1	1	6.0	6.0
CD	F	0	0	3.0	2.0	CD	M	1	1	2.0	2.0
CD	F	0	0	3.0	2.0	CD	M	1	1	3.0	2.0
CD	F	0	0	3.0	3.0	CD	M	0	2	3.0	3.0
CD	F	0	0	3.0	3.0	CD	M	1	1	3.0	3.0
CD	F	0	0	4.0	4.0	CD	M	1	1	3.0	4.0
CD	F	0	0	4.0	5.0	CD	M	1	1	4.0	3.0
CD	F	0	0	5.0	4.0	CD	M	0	2	4.0	4.0
CD	F	0	0	5.0	4.0	CD	M	1	1	4.0	4.0
CD	F	0	0	6.0	5.0	CD	M	1	1	4.0	4.0
CD	M	0	0	3.0	3.0	CD	M	1	1	5.0	4.0
CD	M	0	0	3.0	4.0	CD	M	1	1	5.0	4.0
CD	F	1	0	3.0	2.5	CD	M	1	1	5.0	5.0
CD	M	1	0	3.5	3.5	CD	M	1	1	5.0	6.0
CD	M	1	0	4.0	3.0	CD	M	1	1	6.0	5.0
CD	M	1	0	3.5	4.5	CD	F	2	1	3.0	3.0
CD	M	1	0	4.0	4.0	CD	F	1	2	4.5	4.0
CD	M	0	1	4.5	4.5	CD	F	2	1	4.0	5.0
CD	M	1	0	5.0	6.0	CD	F	2	1	5.0	6.0
CD	M	1	0	5.5	5.5	CD	M	1	2	4.5	4.0
CD	M	0	1	6.0	6.0	CD	M	2	1	5.0	4.0
CD	F	1	0	3.0	3.0	CD	M	2	1	5.0	6.0
CD	F	1	0	3.0	3.0	CD	M	1	2	5.5	6.0
CD	F	1	0	4.0	4.0	CD	M	2	1	7.0	7.0
CD	F	1	0	5.0	3.0	CD	F	2	1	2.0	2.0
CD	M	0	1	2.0	3.0	CD	F	2	1	3.0	3.0
CD	M	1	0	3.0	3.0	CD	F	1	2	5.0	4.0
CD	M	1	0	3.0	4.0	CD	F	2	1	5.0	4.0
CD	M	1	0	4.0	4.0	CD	F	2	1	5.0	5.0
CD	M	0	1	4.0	5.0	CD	F	2	1	5.0	5.0
CD	M	0	1	6.0	6.0	CD	F	1	2	6.0	6.0
CD	F	1	1	3.0	3.0	CD	F	1	2	6.0	6.0
CD	F	2	0	3.5	3.5	CD	M	2	1	3.0	2.0
CD	F	1	1	4.0	5.0	CD	M	1	2	3.0	3.0
CD	M	1	1	3.5	3.5	CD	M	2	1	4.0	4.0
CD	M	2	0	3.5	3.5	CD	M	2	1	5.0	4.0
CD	M	1	1	4.0	3.5	CD	M	2	1	5.0	5.0
CD	M	1	1	4.5	4.5	CD	F	2	2	3.5	3.5
CD	M	1	1	5.0	4.0	CD	F	2	2	4.5	4.5
CD	M	1	1	5.0	5.0	CD	F	2	2	5.0	4.5
CD	M	2	0	5.5	5.0	CD	M	2	2	3.0	2.5

Appendix 9.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
CD	M	1	1	6.0	6.0	CD	M	2	2	3.5	3.5
CD	M	1	1	6.0	6.0	CD	M	2	2	4.0	3.5
CD	M	1	1	9.0	9.0	CD	M	2	2	4.5	4.5
CD	F	0	2	3.0	3.0	CD	M	2	2	4.5	4.5
CD	F	1	1	3.0	3.0	CD	M	2	2	7.0	6.0
CD	F	1	1	3.0	3.0	CD	M	2	2	8.0	8.0
CD	F	1	1	3.0	3.0	CD	F	2	2	3.0	3.0
CD	F	1	1	3.0	4.0	CD	F	2	2	4.0	3.0
CD	F	1	3	4.0	4.0	CD	F	2	2	6.0	6.0
CD	F	2	2	4.0	4.0	CD	F	2	2	7.0	7.0
CD	F	2	2	5.0	3.0	CD	M	2	2	3.0	3.0
CD	F	2	2	5.0	5.0	CD	M	2	2	4.0	4.0
CD	M	2	2	4.0	4.0	IC	F	1	1	5.0	4.0
CD	M	2	2	7.0	5.0	IC	F	1	1	5.0	4.0
CD	F	3	2	3.5	3.5	IC	F	1	1	6.0	4.0
CD	M	2	3	3.5	3.5	IC	M	1	1	4.0	5.0
CD	M	3	2	4.5	4.5	IC	M	2	0	5.0	4.0
CD	M	3	2	5.0	4.0	IC	M	1	1	5.0	5.0
CD	M	3	2	5.0	4.5	IC	M	1	1	7.0	6.0
CD	M	3	2	5.0	5.0	IC	M	1	1	7.0	6.0
CD	M	2	3	5.0	6.0	IC	F	1	2	4.0	4.0
CD	M	2	3	4.0	5.0	IC	F	1	2	5.0	4.0
CD	M	3	3	3.0	3.0	IC	M	1	2	5.0	5.0
CD	M	3	3	4.0	4.5	IC	F	2	2	6.0	6.0
CD	M	3	3	5.0	4.5	DD	F	0	0	3.0	2.0
CD	M	3	3	5.0	5.0	DD	F	0	0	3.0	3.0
CD	F	3	3	5.0	5.0	DD	F	0	0	4.0	4.0
CD	M	3	3	3.0	3.0	DD	M	0	0	2.0	2.0
CD	M	3	3	5.0	3.0	DD	M	0	0	2.0	3.0
CD	M	3	3	5.0	5.0	DD	M	0	0	3.0	3.0
CD	M	3	3	6.0	5.0	DD	M	0	0	3.0	3.0
CD	M	3	3	6.0	6.0	DD	M	0	0	3.0	3.0
CD	M	4	4	5.0	5.0	DD	M	0	0	3.0	3.0
GG	F	0	2	5.0	4.0	DD	M	0	0	4.0	3.0
GG	F	1	1	5.0	4.5	DD	M	0	0	4.0	3.0
GG	M	1	1	4.5	5.0	DD	M	0	0	4.0	3.0
GG	M	1	1	7.0	6.0	DD	M	0	1	3.0	3.0
GG	F	1	2	4.0	3.0	DD	M	0	1	3.0	3.0
GG	M	1	2	3.5	4.0	DD	M	1	0	3.0	3.0
GG	M	2	1	5.0	3.5	DD	M	0	1	4.0	4.0
GG	F	2	2	3.0	3.0	DD	M	0	1	4.0	4.0
GG	F	2	2	3.0	3.0	DD	M	0	1	5.0	4.0
GG	F	3	1	3.0	3.5	DD	M	1	1	4.0	3.0
GG	F	2	2	5.0	5.0	DD	M	2	2	2.0	3.0
GG	F	2	2	6.0	6.0	9C	F	0	0	2.0	2.0
GG	M	3	1	2.5	2.5	9C	F	0	0	2.0	2.0
GG	M	2	2	3.0	3.0	9C	F	0	0	3.0	2.0
GG	M	1	3	4.0	4.0	9C	F	0	0	3.0	3.5
GG	M	2	2	5.0	5.0	9C	F	0	0	4.5	4.0

Appendix 9.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
GG	M	2	2	5.5	5.0	9C	F	0	0	4.5	4.5
GG	F	2	3	2.5	2.5	9C	M	0	0	2.5	1.5
GG	F	3	2	4.0	3.0	9C	M	0	0	3.0	3.0
GG	F	2	3	4.0	4.0	9C	M	0	0	3.0	3.0
GG	F	3	2	5.0	6.0	9C	M	0	0	3.5	3.5
GG	M	2	3	4.0	3.0	9C	M	0	0	4.0	5.0
GG	M	3	3	3.0	2.5	9C	M	0	0	4.5	5.0
GG	M	3	4	3.5	4.0	9C	F	0	0	3.0	3.0
IC	F	0	0	4.0	3.0	9C	F	0	0	3.0	4.0
IC	F	0	0	4.0	3.0	9C	F	0	0	3.0	4.0
IC	F	0	0	5.0	5.0	9C	F	0	0	4.0	4.0
IC	F	0	0	6.0	6.0	9C	F	0	0	5.0	4.0
IC	M	0	0	4.0	4.0	9C	F	0	0	6.0	4.0
IC	M	0	0	5.0	5.0	9C	F	0	0	6.0	5.0
IC	M	0	0	6.0	5.0	9C	F	0	0	7.0	6.0
IC	F	1	0	5.0	5.0	9C	M	0	0	3.0	4.0
IC	M	0	1	3.0	3.0	9C	M	0	0	3.0	4.0
IC	M	1	0	5.0	5.0	9C	M	0	0	4.0	3.0
IC	M	1	0	6.0	5.0	9C	M	0	0	4.0	4.0
IC	F	1	1	3.0	3.0	9C	M	0	0	4.0	4.0
IC	F	1	1	4.0	3.0	9C	M	0	0	4.0	4.0
IC	F	1	1	4.0	3.0	9C	M	0	0	5.0	4.0
IC	F	1	1	4.0	4.0	9C	M	0	0	5.0	5.0
IC	F	1	1	4.0	5.0	9C	M	0	0	6.0	5.0
9C	M	0	0	6.0	5.0	9C	M	0	0	6.0	6.0
9C	M	0	0	6.0	6.0	9C	F	2	1	2.5	4.0
9C	F	1	0	2.0	2.0	9C	F	1	2	5.0	4.0
9C	F	1	0	3.5	3.0	9C	F	2	1	5.0	4.5
9C	F	1	0	4.0	4.0	9C	M	2	1	2.0	2.0
9C	M	0	1	4.0	4.0	9C	M	2	1	2.5	2.0
9C	M	1	0	4.5	4.5	9C	M	2	1	2.5	3.0
9C	F	1	0	4.0	3.0	9C	M	2	1	3.0	3.0
9C	F	0	1	4.0	4.0	9C	M	2	1	3.0	3.0
9C	F	1	0	4.0	4.0	9C	M	3	0	3.0	3.0
9C	F	1	0	5.0	4.0	9C	M	2	1	3.0	3.5
9C	F	1	0	5.0	4.0	9C	M	2	1	3.5	3.5
9C	F	1	0	5.0	5.0	9C	M	2	1	3.5	3.5
9C	M	0	1	4.0	5.0	9C	M	2	1	6.0	5.0
9C	M	1	0	5.0	7.0	9C	F	2	1	3.0	4.0
9C	M	1	0	6.0	6.0	9C	F	2	1	3.0	4.0
9C	F	1	1	2.0	2.0	9C	F	2	1	4.0	4.0
9C	F	1	1	2.5	1.5	9C	F	2	1	4.0	4.0
9C	F	1	1	2.5	2.5	9C	F	2	1	5.0	3.0
9C	F	0	2	3.0	3.5	9C	F	2	1	4.0	5.0
9C	F	1	1	4.0	3.5	9C	F	2	1	5.0	4.0
9C	F	1	1	4.5	4.5	9C	F	2	1	5.0	5.0
9C	M	1	1	2.5	2.0	9C	M	1	2	4.0	3.0
9C	M	1	1	2.5	2.5	9C	M	1	2	5.0	5.0
9C	M	1	1	3.0	2.5	9C	M	1	2	5.0	5.0

Appendix 9.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
9C	M	1	1	2.5	3.5	9C	F	2	2	1.0	1.0
9C	M	1	1	5.0	3.0	9C	F	2	2	2.0	2.0
9C	M	2	0	5.0	4.0	9C	F	1	3	3.0	3.0
9C	M	1	1	6.0	4.0	9C	F	2	2	3.5	2.5
9C	F	1	1	3.0	4.0	9C	F	3	1	3.5	3.0
9C	F	1	1	4.0	4.0	9C	F	2	2	5.0	5.5
9C	F	1	1	4.0	4.0	9C	M	2	2	3.0	3.0
9C	F	1	1	5.0	4.0	9C	M	2	2	3.5	2.5
9C	F	1	1	5.0	4.0	9C	M	2	2	3.0	3.5
9C	F	1	1	5.0	4.0	9C	M	1	3	4.0	3.5
9C	F	1	1	5.0	4.0	9C	M	2	2	5.0	5.0
9C	F	1	1	5.0	5.0	9C	M	2	2	6.0	6.0
9C	F	1	1	6.0	5.0	9C	F	2	2	3.0	3.0
9C	M	1	1	3.0	3.0	9C	F	2	2	5.0	4.0
9C	M	1	1	4.0	3.0	9C	F	2	2	5.0	5.0
9C	M	1	1	4.0	3.0	9C	F	3	1	6.0	6.0
9C	M	1	1	4.0	4.0	9C	M	2	2	4.0	4.0
9C	M	1	1	4.0	4.0	9C	M	2	2	4.0	4.0
9C	M	1	1	5.0	3.0	9C	M	2	2	4.0	4.0
9C	M	1	1	5.0	4.0	9C	M	2	2	4.0	5.0
9C	M	1	1	5.0	4.0	9C	F	3	2	4.0	4.0
9C	M	1	1	5.0	5.0	9C	M	2	3	2.0	2.0
9C	M	1	1	5.0	5.0	9C	M	3	2	3.5	2.0
9C	M	1	1	5.0	5.0	9C	M	2	3	4.0	3.0
9C	M	1	1	6.0	6.0	9C	M	3	2	3.5	3.5
9C	M	1	1	7.0	6.0	9C	M	3	2	5.0	5.0
9C	M	1	1	7.0	6.0	9C	F	2	3	4.0	4.0
9C	M	3	3	3.0	2.5	9C	F	1	2	2.0	3.0
9C	F	3	3	3.0	3.0	9C	M	3	3	3.0	3.0
9C	F	2	1	2.5	2.5	9C	F	3	3	3.0	3.5
9C	M	3	3	4.0	2.5	9C	F	1	2	2.5	3.0
9C	F	3	3	3.5	4.5	9C	M	3	3	3.5	3.5
9C	M	3	3	3.5	4.0	7G	M	0	0	4.0	6.0
9C	M	3	3	4.0	4.0	7G	M	0	0	5.0	5.0
9C	F	4	5	4.0	4.0	7G	M	0	0	6.0	6.0
DL	F	0	0	5.0	4.0	7G	M	0	0	7.0	5.0
DL	F	0	0	5.0	5.0	7G	M	0	0	7.0	7.0
DL	F	0	0	6.0	6.0	7G	M	0	1	5.0	4.0
DL	M	0	0	6.0	6.0	7G	M	0	1	6.0	4.5
DL	F	1	0	5.0	4.0	7G	M	1	0	6.0	6.0
DL	F	1	0	5.0	6.0	7G	M	1	0	7.0	6.0
DL	F	0	2	5.0	4.0	7G	F	1	0	6.0	6.0
DL	F	2	0	4.0	5.0	7G	M	1	0	5.0	5.0
DL	F	2	1	5.0	5.0	7G	M	0	1	6.0	5.0
DL	M	1	2	6.0	6.0	7G	M	1	0	6.0	6.0
DL	F	2	2	4.0	4.0	7G	F	1	1	4.5	4.0
DL	F	2	2	5.0	4.0	7G	F	1	1	4.0	5.0
DL	F	2	2	5.0	4.0	7G	F	1	1	5.0	4.0
DL	F	2	2	5.0	4.0	7G	F	1	1	5.0	5.0

Appendix 9.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
DL	F	2	2	6.0	5.0	7G	F	1	1	7.0	7.0
DL	M	2	2	6.0	6.0	7G	F	1	1	8.0	6.0
DL	F	3	3	4.0	5.0	7G	M	1	1	4.0	3.5
DL	M	4	3	5.0	5.0	7G	M	1	1	4.0	4.0
LD	F	0	0	3.0	3.0	7G	M	1	1	5.5	4.5
LD	F	0	0	4.0	4.0	7G	M	2	0	6.0	6.0
LD	F	0	0	5.0	4.0	7G	F	1	1	4.0	4.0
LD	F	0	0	5.0	4.0	7G	F	2	0	6.0	5.0
LD	F	0	0	5.0	4.0	7G	M	0	2	3.0	3.0
LD	F	0	0	5.0	5.0	7G	M	1	1	5.0	5.0
LD	F	0	0	5.0	5.0	7G	F	2	1	3.5	3.5
LD	F	0	0	5.0	5.0	7G	F	1	2	6.0	7.0
LD	F	0	0	6.0	5.0	7G	F	2	1	7.0	7.0
LD	F	0	0	6.0	7.0	7G	F	2	1	8.0	6.0
LD	M	0	0	4.0	4.0	7G	M	1	2	5.0	4.5
LD	M	0	0	6.0	5.0	7G	M	1	2	5.0	5.0
LD	M	0	0	8.0	6.0	7G	M	2	1	5.0	5.0
LD	F	0	1	5.0	4.0	7G	M	1	2	7.0	7.0
LD	F	1	0	6.0	5.0	7G	M	2	1	7.0	5.0
LD	M	1	1	5.0	4.0	7G	F	2	2	3.0	2.5
LD	M	1	1	5.0	5.0	7G	F	2	2	3.5	5.0
LD	M	1	1	5.0	6.0	7G	F	2	2	5.0	5.0
7G	F	0	0	4.0	3.5	7G	F	2	2	6.0	6.0
7G	F	0	0	5.5	6.0	7G	M	3	1	5.0	4.0
7G	F	0	0	7.0	6.0	7G	M	3	1	5.5	5.0
7G	M	0	0	3.5	2.5	7G	M	2	2	6.0	5.5
7G	M	0	0	4.0	4.0	7G	F	2	2	4.0	5.0
7G	M	0	0	5.5	4.5	7G	F	2	2	5.0	4.0
7G	M	0	0	7.0	7.0	7G	F	2	2	5.0	5.0
7G	M	0	0	7.0	8.0	7G	F	2	2	6.0	6.0
7G	F	0	0	4.0	4.0	7G	M	2	2	5.0	5.0
7G	F	0	0	5.0	4.0	7G	M	2	2	6.0	6.0
7G	F	0	0	5.0	5.0	7G	M	2	2	7.0	6.0
7G	F	0	0	6.0	5.0	7J	F	0	0	4.0	4.0
7G	M	0	0	5.0	4.0	7J	F	0	0	4.0	5.0
7G	M	3	2	6.0	6.0	7J	F	0	0	6.0	4.0
7G	M	3	2	10.0	9.5	7J	M	0	0	4.0	4.5
7G	F	3	3	5.0	6.0	7J	M	0	0	6.0	6.0
7G	M	3	3	6.0	6.0	7J	F	0	0	3.0	3.0
7G	M	3	3	6.0	6.0	7J	F	0	0	4.0	4.0
7J	F	0	0	5.0	5.0	7J	F	0	0	5.0	4.0
7J	M	0	0	3.0	3.0	7J	F	0	0	5.0	4.0
7J	M	0	0	4.0	4.0	7J	F	0	0	5.0	5.0
7J	M	0	0	4.0	5.0	7J	F	0	0	5.0	5.0
7J	M	0	0	5.0	4.0	7J	F	0	0	6.0	5.0
7J	M	0	0	5.0	4.0	7J	F	2	2	4.0	3.0
7J	M	0	0	5.0	4.0	7J	F	2	2	4.0	4.0
7J	M	0	0	5.0	5.0	7J	F	2	2	5.0	4.0
7J	M	0	0	5.0	5.0	7J	F	3	2	3.5	3.5

Appendix 9.2(Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin thickness Left	Skin thickness Right
7J	M	0	0	5.0	5.0	7J	M	3	2	2.5	3.0
7J	M	0	0	5.0	5.0	7J	M	2	3	3.0	3.0
7J	F	1	0	3.5	3.5	7J	M	2	3	3.5	3.0
7J	M	0	1	3.0	3.0	7J	M	2	3	3.0	4.0
7J	M	1	0	3.0	3.0	7J	M	2	3	5.5	4.5
7J	M	1	0	3.5	3.5	7J	F	2	3	4.0	4.0
7J	F	1	0	3.0	3.0	7J	F	2	3	5.0	4.0
7J	F	1	0	3.0	4.0	7J	F	3	3	5.0	4.0
7J	F	1	0	6.0	4.0	7J	M	3	3	2.0	2.0
7J	M	0	1	4.0	3.0	7J	F	2	4	5.0	5.0
7J	M	1	0	5.0	4.0	7J	F	2	5	4.0	5.0
7J	M	1	0	5.0	5.0	OR	M	1	1	4.0	4.0
7J	M	1	0	5.0	6.0	OR	M	2	1	6.0	6.0
7J	M	1	0	6.0	5.0	OR	M	2	2	3.0	3.0
7J	F	1	1	3.0	3.5	OR	M	2	2	5.0	4.0
7J	F	0	2	3.5	3.5	OR	F	3	3	6.0	6.0
7J	F	1	1	4.0	4.0	OR	F	3	3	6.0	7.0
7J	M	1	1	3.0	2.0	OR	M	3	3	3.0	3.0
7J	M	2	0	3.5	3.0	NY	F	0	0	3.0	3.0
7J	M	1	1	4.0	4.0	NY	F	0	0	4.0	3.0
7J	M	1	1	4.5	4.5	NY	F	0	0	4.0	4.0
7J	M	1	1	5.0	5.0	NY	F	0	0	4.0	4.0
7J	F	1	1	4.0	4.0	NY	F	0	0	4.0	4.0
7J	F	1	1	4.0	4.0	NY	F	0	0	4.0	4.0
7J	F	1	1	5.0	4.0	NY	F	0	0	5.0	4.0
7J	F	1	1	5.0	4.0	NY	F	0	0	5.0	5.0
7J	F	1	1	6.0	6.0	NY	F	0	0	5.0	5.0
7J	M	1	1	4.0	5.0	NY	F	0	0	5.0	5.0
7J	M	1	1	5.0	4.0	NY	M	0	0	7.0	5.0
7J	M	1	1	5.0	4.0	NY	M	0	0	7.0	6.0
7J	M	1	1	5.0	5.0	NY	F	0	1	4.0	4.0
7J	M	1	2	3.0	2.5	NY	F	1	0	4.0	4.0
7J	M	1	2	3.5	2.5	NY	F	0	1	5.0	5.0
7J	M	2	1	3.0	4.0	NY	M	1	0	6.0	5.0
7J	M	2	1	4.0	3.5	7J	F	2	2	5.0	4.5
7J	M	2	1	5.0	4.5	7J	F	2	2	5.0	5.0
7J	M	1	2	5.0	5.0	7J	M	2	2	2.5	3.5
7J	F	1	2	4.0	5.0	7J	M	2	2	3.5	3.0
7J	F	1	2	5.0	4.0	7J	M	2	2	4.0	4.0
7J	F	1	2	5.0	5.0	7J	M	2	2	5.0	4.5
7J	M	1	2	4.0	4.0	7J	M	2	2	5.0	5.0
7J	F	1	3	3.0	2.5						

Appendix 9.3: Statistical analysis: The effect of skin thickness on bursitis

***** Regression Analysis ***** Farm 7J

Response variate: avscowr
Fitted terms: Constant avtwr

***** Summary of analysis *****

	d.f.	s.s.	m.s.	v.r.
Regression	1	4.79	4.7915	5.69
Residual	82	69.10	0.8427	
Total	83	73.89	0.8902	

Percentage variance accounted for 5.3

* MESSAGE: The following units have large standardized residuals:
491 2.73

* MESSAGE: The following units have high leverage:
410 0.068
454 0.068
489 0.090

***** Estimates of regression coefficients *****

	estimate	s.e.	t
Constant	2.280	0.5044.52	
avtwr	-0.283	0.118	-2.38

***** Regression Analysis ***** Farm 9C

Response variate: avscowr
Fitted terms: Constant avtwr

***** Summary of analysis *****

	d.f.	s.s.	m.s.	v.r.
Regression	1	3.8	3.7996	4.65
Residual	144	117.6	0.8169	
Total	145	121.4	0.8375	

Percentage variance accounted for 2.5

* MESSAGE: The following units have large standardized residuals:
339 3.70

Appendix 9.3 (Contd.)

* MESSAGE: The following units have high leverage:
213 0.045
274 0.045
275 0.045
303 0.055

***** Estimates of regression coefficients *****

	estimate	s.e.	t
Constant	1.756	0.277	6.34
avtwr	-0.1474	0.0683	-2.16

******* Regression Analysis ******* **Farm CG**

Response variate: avscowr
Fitted terms: Constant avtwr

***** Summary of analysis *****

	d.f.	s.s.	m.s.	v.r.
Regression	1	1.434	1.4338	4.04
Residual	22	7.806	0.3548	
Total	23	9.240	0.4017	

Percentage variance accounted for 11.7

* MESSAGE: The following units have large standardized residuals:
165 2.48

* MESSAGE: The following units have high leverage:
145 0.257
153 0.178

***** Estimates of regression coefficients *****

	estimate	s.e.	t
Constant	2.896	0.472	6.14
avtwr	-0.227	0.113	-2.01

Appendix 9.4: Coloured pigs: the farm ID bursitis score of left or right leg and length of each leg in mm.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
FP	F	0	0	22.5	22.5	FP	M	0	0	26.0	26.5
FP	F	0	0	22.5	23.0	FP	M	0	0	26.5	26.0
FP	F	0	0	23.0	23.0	7Z	F	0	0	24.5	24.0
FP	F	0	0	23.0	23.5	7Z	M	0	0	21.5	22.0
FP	F	0	0	23.0	24.0	7Z	M	0	0	25.0	25.5
FP	F	0	0	23.5	24.0	7Z	F	1	0	23.0	23.0
FP	F	0	0	24.0	24.0	7Z	F	0	1	24.0	24.0
FP	F	0	0	24.0	24.0	7Z	M	0	1	23.0	23.0
FP	F	0	0	24.0	24.0	7Z	F	1	1	23.5	23.5
FP	F	0	0	24.0	24.5	7Z	F	1	1	23.5	24.0
FP	F	0	0	24.5	25.0	7Z	F	1	1	24.0	24.0
FP	F	0	0	25.0	24.5	7Z	F	1	1	24.0	24.0
FP	F	0	0	25.0	24.5	7Z	F	1	1	24.5	25.0
FP	F	0	0	25.0	25.0	7Z	M	1	1	21.5	22.0
FP	F	0	0	25.0	25.0	7Z	M	1	1	23.0	23.0
FP	F	0	0	25.0	25.0	7Z	M	1	1	23.0	23.5
FP	F	0	0	25.0	25.0	7Z	F	1	2	23.0	22.5
FP	F	0	0	25.0	25.5	7Z	F	1	2	24.0	24.0
FP	F	0	0	25.0	25.5	7Z	F	1	2	25.0	25.0
FP	F	0	0	25.5	25.5	7Z	F	2	2	24.0	24.0
FP	F	0	0	25.5	25.5	7Z	F	1	3	24.5	24.5
FP	F	0	0	25.5	26.0	7Z	F	5	5	24.0	23.5
FP	F	0	0	25.5	26.0	2J	M	0	0	22.5	23.0
FP	F	0	0	26.0	26.0	2J	M	0	0	23.0	23.0
FP	F	0	0	26.0	26.5	2J	M	0	0	23.0	23.5
FP	M	0	0	23.0	23.0	2J	M	0	0	23.0	23.5
FP	M	0	0	23.5	23.5	2J	M	0	0	23.0	23.5
FP	M	0	0	23.5	23.5	2J	M	0	0	23.5	23.0
FP	M	0	0	23.5	24.0	2J	M	0	0	23.5	23.5
FP	M	0	0	24.0	23.5	2J	M	0	0	23.5	23.5
FP	M	0	0	24.0	24.0	2J	M	0	0	23.5	24.0
FP	M	0	0	24.0	24.0	2J	M	0	0	23.5	24.0
FP	M	0	0	24.0	25.0	2J	M	0	0	24.0	23.5
FP	M	0	0	25.0	24.5	2J	M	0	0	24.0	24.0
FP	M	0	0	25.0	25.0	2J	M	0	0	24.0	24.0
FP	M	0	0	25.0	25.0	2J	M	0	0	24.0	24.0
FP	M	0	0	25.0	25.0	2J	M	0	0	24.0	24.0
FP	M	0	0	25.0	25.5	2J	M	0	0	24.0	24.0
FP	M	0	0	25.5	25.5	2J	M	0	0	24.0	24.0
FP	M	0	0	25.5	25.5	2J	M	0	0	24.0	24.5
FP	M	0	0	25.5	26.0	2J	M	0	0	24.0	24.5
FP	M	0	0	25.5	26.0	2J	M	0	0	24.0	24.5
FP	M	0	0	26.5	27.0	2J	M	0	0	24.0	25.0
FP	F	0	1	26.0	26.0	2J	M	0	0	24.0	25.0
FP	F	0	0	22.0	23.0	2J	M	0	0	24.0	25.0
FP	F	0	0	23.0	22.5	2J	M	0	0	24.5	24.5
FP	F	0	0	24.0	23.0	2J	M	0	0	25.0	25.0

Appendix 9.4 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
FP	F	0	0	24.0	24.0	2J	M	0	0	25.0	25.0
FP	F	0	0	24.0	24.0	2J	M	0	0	25.0	25.0
FP	F	0	0	24.0	24.5	2J	M	0	0	25.0	25.5
FP	F	0	0	24.5	24.0	2J	M	0	0	25.0	25.5
FP	F	0	0	25.0	25.0	2J	M	0	0	25.0	25.5
FP	F	0	0	26.0	25.5	2J	M	1	0	23.5	23.5
FP	M	0	0	24.0	24.5	2J	M	0	1	23.5	24.0
FP	M	0	0	25.5	25.0	2J	M	1	0	24.0	24.0
FP	M	0	0	25.5	26.0	2J	M	0	1	24.0	25.0
FP	M	0	0	26.0	26.0	2J	M	1	0	24.5	24.5
FP	M	0	0	26.0	26.0	2J	M	1	0	24.5	24.5
FP	M	0	0	26.0	26.0	2J	M	1	0	24.5	25.0
2J	M	1	0	25.0	25.0	4J	F	0	1	24.5	24.5
2J	M	0	1	26.0	25.0	4J	F	0	1	24.5	25.0
2J	M	1	0	25.5	25.5	4J	F	0	1	25.0	24.5
2J	M	1	1	23.0	23.5	4J	F	0	1	25.0	25.0
2J	M	1	1	24.0	24.0	4J	F	0	1	25.0	25.0
2J	M	2	0	23.5	24.5	4J	F	1	1	22.5	23.0
2J	M	1	1	24.0	24.5	4J	F	1	1	23.5	23.0
2J	M	1	1	24.0	25.5	4J	F	2	0	23.5	23.5
2J	M	2	0	24.5	25.0	4J	F	1	1	24.0	24.0
2J	M	2	0	24.5	25.0	4J	F	0	2	25.0	25.0
2J	M	1	1	25.0	25.0	4J	F	1	1	25.0	25.5
2J	M	1	1	25.5	25.5	4J	F	1	1	26.0	26.5
2J	M	1	1	25.5	26.0	4J	F	2	1	22.5	23.0
2J	M	1	1	27.0	27.5	4J	F	2	1	24.0	22.5
2J	M	1	2	23.0	22.0	4J	F	1	2	24.0	24.0
2J	M	1	2	23.5	24.5	4J	F	1	2	25.0	25.0
2J	M	1	2	24.0	24.5	4J	F	2	2	23.5	24.0
2J	M	2	1	24.5	25.0	4J	F	2	2	24.0	24.0
2J	M	1	2	25.0	25.0	4J	F	2	2	25.0	24.5
2J	M	2	1	24.5	25.5	4J	F	1	4	23.0	23.0
2J	M	2	1	25.0	25.0	4J	F	3	2	24.0	24.0
2J	M	2	1	26.0	26.0	4J	F	4	4	23.5	24.5
2J	M	2	1	26.0	26.0	IP	M	0	0	24.0	24.0
2J	M	1	2	27.0	26.5	IP	F	1	1	23.0	23.0
2J	M	3	1	24.0	24.0	IP	M	1	1	23.0	23.0
2J	M	2	2	25.0	26.0	IP	M	1	2	22.5	23.0
2J	M	2	2	25.5	26.0	IP	F	2	2	24.5	24.5
2J	M	3	1	26.0	26.5	IP	M	2	2	24.5	24.5
2J	M	3	3	27.5	28.0	IP	M	2	2	25.0	25.0
2J	M	4	4	26.0	25.5	4J	F	0	0	24.0	24.0
4J	F	0	0	22.0	22.5	4J	F	0	0	24.0	24.0
4J	F	0	0	23.0	23.0	4J	F	0	0	24.0	24.5
4J	F	0	0	23.0	23.0	4J	F	0	0	24.0	24.5
4J	F	0	0	23.0	23.5	4J	F	0	0	24.5	24.5
4J	F	0	0	23.0	23.5	4J	F	0	0	25.0	24.5
4J	F	0	0	23.0	24.0	4J	F	0	0	25.0	25.0
4J	F	0	0	23.0	24.0	4J	F	0	0	25.0	25.0

Appendix 9.4 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
4J	F	0	0	23.5	23.5	4J	F	0	0	25.0	25.0
4J	F	0	0	23.5	24.0	4J	F	0	1	22.0	22.0
4J	F	0	0	23.5	24.0	4J	F	1	0	21.5	22.5
4J	F	0	0	24.0	24.0	4J	F	1	0	23.0	23.0
4J	F	0	0	24.0	24.0	4J	F	0	1	23.0	23.5
4J	F	0	0	24.0	24.0	4J	F	1	0	23.5	23.0
4J	F	0	0	24.0	24.0	4J	F	1	0	23.0	24.0
4J	F	0	1	24.0	23.5	4J	F	0	1	24.0	24.0
4J	F	1	0	24.0	24.5	4J	F	0	1	24.5	24.5

Appendix 9.5: White pigs: the farm ID the bursitis score of the left and right leg and the length of each leg in cms.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
DD	F	1	1	22.0	23.0	UY	F	1	1	24.0	24.0
DD	M	1	1	22.5	22.5	UY	F	1	1	24.0	24.0
DD	M	1	1	24.0	24.0	UY	F	0	2	24.5	24.5
DD	M	1	1	24.5	24.0	UY	F	1	1	26.5	26.5
DD	M	1	1	25.0	25.0	UY	M	1	1	24.5	25.0
DD	M	1	1	25.0	25.0	UY	M	1	1	24.5	25.5
DD	F	2	1	24.5	24.5	UY	F	2	1	21.5	21.5
DD	M	1	2	23.5	23.5	UY	F	2	1	21.5	22.0
DD	M	2	1	24.5	24.5	UY	F	2	1	24.0	24.5
DD	F	2	2	23.5	24.0	UY	F	2	1	26.5	26.0
DD	F	2	2	25.0	25.0	UY	M	2	1	22.5	22.0
DD	F	2	2	25.5	25.5	UY	M	2	1	23.0	23.0
DD	M	2	2	22.0	22.0	UY	M	2	1	23.5	23.5
DD	M	2	2	23.0	24.0	UY	M	1	2	24.0	24.0
DD	M	2	2	23.5	23.5	UY	F	2	2	22.5	23.0
DD	M	1	3	24.0	24.0	UY	F	2	2	23.0	23.5
DD	M	2	2	24.0	24.0	UY	F	2	2	23.0	23.5
DD	M	2	2	24.0	24.0	UY	F	2	2	24.0	23.5
DD	M	2	2	24.0	24.0	UY	F	2	2	24.5	24.5
DD	M	2	2	24.0	24.0	UY	F	2	2	25.0	25.0
DD	M	2	2	24.5	24.5	UY	M	2	2	23.5	23.5
DD	M	2	2	24.5	24.5	UY	M	2	2	23.5	24.0
DD	M	2	2	24.5	24.5	UY	M	2	2	24.5	24.5
DD	M	2	2	25.0	24.5	UY	M	2	2	25.0	25.0
DD	M	2	2	25.0	25.0	UY	F	2	3	23.0	22.5
DD	M	2	2	25.0	25.0	UY	F	3	2	23.5	23.5
DD	M	2	2	26.0	26.0	UY	M	3	2	24.0	24.0
DD	F	2	3	22.0	22.0	UY	M	2	3	24.0	24.5
DD	F	3	2	23.5	24.0	UY	M	3	2	25.0	25.0
DD	F	3	2	24.0	24.0	UY	M	3	3	24.0	24.5
DD	F	3	2	24.0	24.0	UY	M	3	3	24.0	25.0
DD	F	3	2	24.0	24.0	UY	M	4	3	24.0	24.0
DD	F	3	2	25.0	25.0	WK	M	0	0	25.5	26.0
DD	F	3	2	25.5	25.5	WK	M	0	0	26.0	26.0
DD	M	2	3	24.0	24.0	WK	F	0	1	26.0	26.0
DD	M	2	3	24.0	24.0	WK	M	0	1	25.0	25.0
DD	M	3	2	25.0	25.0	WK	M	1	0	27.0	27.0
DD	M	3	2	25.0	25.5	WK	F	1	1	24.5	24.5
DD	M	3	2	26.0	26.0	WK	M	1	1	24.5	24.5
DD	M	3	3	24.0	23.5	WK	M	1	1	25.0	24.0
DD	M	3	3	24.0	23.5	WK	M	1	1	25.0	25.0
DD	M	3	3	24.0	24.0	WK	M	1	1	25.0	25.0
DD	M	3	3	24.5	24.5	WK	M	1	1	26.0	25.0
DD	M	3	3	25.0	25.0	WK	M	1	1	27.0	27.0
DD	M	3	3	25.0	25.0	WK	F	2	1	24.0	23.5
DD	M	3	3	25.0	25.5	WK	F	2	1	24.5	24.0

Appendix 9.5 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
DD	M	3	3	25.5	25.5	WK	F	2	1	25.0	25.0
DD	F	3	4	26.0	26.0	WK	F	1	2	26.0	26.5
DD	M	4	3	26.0	26.0	WK	M	1	2	23.5	23.5
DD	M	2	5	27.0	27.0	WK	M	2	1	26.0	25.0
DD	M	4	4	25.0	25.5	WK	F	3	1	25.5	25.0
UY	F	0	0	23.0	23.5	WK	M	3	1	24.5	24.0
UY	F	0	0	25.0	24.5	WK	M	2	2	24.5	24.5
UY	F	1	0	24.0	24.0	WK	F	2	3	27.0	26.0
UY	M	0	1	24.5	24.5	WK	M	3	2	26.0	26.0
UY	M	1	0	25.0	26.0	WK	F	4	4	26.0	25.5
UY	M	0	1	27.5	28.0	AO	F	0	1	26.0	26.0
UY	F	1	1	21.0	21.0	AO	F	0	1	28.0	28.5
AO	M	1	0	27.0	27.0	RA	M	2	2	27.5	27.0
AO	F	1	1	25.0	25.0	RA	M	2	2	27.5	27.0
AO	F	1	1	26.0	26.0	RA	M	1	3	27.5	28.0
AO	F	1	1	26.0	26.0	RA	M	2	3	26.0	25.5
AO	M	1	1	28.0	28.0	RA	M	3	2	25.5	26.0
AO	F	2	1	26.0	26.0	RA	M	2	3	26.0	26.0
AO	F	1	2	27.5	27.0	RA	M	3	2	27.0	28.0
AO	M	1	2	28.0	28.0	RA	M	3	2	27.5	28.0
AO	F	2	2	26.5	26.0	RA	M	3	3	25.5	25.5
AO	F	2	2	26.5	26.0	EF	F	0	0	23.0	23.0
AO	F	2	2	28.5	28.0	EF	M	0	0	25.0	25.0
AO	F	3	2	27.5	27.5	EF	F	0	1	22.0	22.0
AO	F	2	3	29.5	29.5	EF	M	0	1	22.0	22.0
AO	F	5	2	26.0	26.0	EF	F	0	2	21.5	23.0
AR	F	0	1	25.0	25.0	EF	F	1	1	23.5	23.5
AR	F	0	1	26.0	25.5	EF	F	1	1	24.0	23.5
AR	F	0	1	26.0	26.0	EF	M	1	1	24.0	24.0
AR	F	1	0	26.0	26.0	EF	F	2	1	23.0	24.5
AR	F	1	0	27.0	27.0	EF	F	2	1	25.5	25.0
AR	M	1	0	26.0	26.0	EF	M	2	2	23.0	23.0
AR	F	1	1	25.5	25.0	EF	M	2	2	24.0	23.5
AR	F	1	1	26.0	26.0	EF	F	3	2	21.5	21.5
AR	F	1	1	26.0	26.0	EF	M	2	3	24.0	24.5
AR	F	1	1	27.0	27.0	EF	M	4	4	25.5	26.0
AR	F	1	1	27.0	27.0	3N	F	0	0	23.0	23.0
AR	M	1	1	26.0	26.0	3N	F	0	0	23.5	24.0
AR	M	2	1	25.0	25.0	3N	F	0	0	24.5	24.5
AR	M	2	1	26.0	26.0	3N	F	0	0	26.0	26.0
AR	F	2	2	26.0	25.5	3N	M	0	0	24.0	24.0
RA	M	0	1	26.5	26.0	3N	M	0	0	24.5	25.0
RA	F	1	1	24.0	24.0	3N	M	0	0	25.0	25.5
RA	F	1	1	25.5	25.0	3N	F	0	1	24.0	24.0
RA	F	1	1	26.0	26.0	3N	F	0	1	26.0	26.5
RA	F	1	1	27.0	26.5	3N	M	1	0	23.0	23.0
RA	F	1	1	27.5	27.0	3N	M	1	0	23.5	23.0
RA	F	1	1	27.5	27.0	3N	M	1	0	23.5	24.0
RA	M	1	1	26.5	26.5	3N	M	0	1	24.0	24.0

Appendix 9.5 (Contd.)

Farm ID	Sex	Bursitis score Left	Right	Leg length Left	Right	Farm ID	Sex	Bursitis score Left	Right	Leg length Left	Right
RA	M	1	1	27.0	27.0	3N	M	1	0	24.0	24.0
RA	M	1	1	27.0	27.0	3N	M	0	1	24.5	24.5
RA	M	1	1	27.0	27.0	3N	M	1	0	24.5	24.5
RA	M	1	1	27.0	27.0	3N	M	1	0	24.5	25.0
RA	M	0	2	27.5	28.0	3N	M	1	0	25.0	25.5
RA	F	1	2	26.0	26.0	3N	F	1	1	23.5	23.5
RA	F	2	1	26.0	26.0	3N	F	1	1	24.0	24.0
RA	F	1	2	28.0	28.0	3N	F	1	1	24.0	24.0
RA	F	2	1	28.0	28.0	3N	F	1	1	25.0	24.0
RA	M	1	2	25.5	25.5	3N	F	1	1	24.5	25.0
RA	M	1	2	26.0	26.0	3N	F	1	1	25.0	25.0
RA	M	2	1	26.0	26.0	3N	F	1	1	25.5	24.5
RA	M	1	2	27.0	26.5	3N	M	1	1	23.5	23.5
RA	M	1	2	27.0	26.5	3N	M	1	1	23.5	23.5
RA	M	2	1	27.0	27.0	3N	M	1	1	23.5	24.0
RA	M	2	1	28.0	27.5	3N	M	1	1	24.0	23.5
RA	M	1	2	28.8	28.0	3N	M	0	2	24.0	24.0
RA	F	2	2	25.0	24.5	3N	M	1	1	24.0	24.0
RA	F	2	2	25.5	25.5	3N	M	1	1	24.0	24.5
RA	F	2	2	25.5	26.0	3N	M	1	1	24.5	24.5
RA	F	2	2	26.0	26.0	3N	M	1	1	24.5	24.5
RA	F	2	2	26.0	26.0	3N	M	1	1	24.5	25.0
RA	M	2	2	25.0	25.0	3N	M	1	1	24.5	25.0
RA	M	2	2	26.0	26.0	3N	M	1	1	25.0	24.5
RA	M	2	2	26.0	26.0	3N	M	1	1	25.0	25.0
RA	M	2	2	27.0	27.0	3N	M	1	1	25.0	25.0
3N	M	2	0	25.0	25.0	OR	M	1	1	24.5	24.5
3N	M	1	1	25.5	25.0	OR	M	1	1	25.0	25.0
3N	M	1	1	25.5	26.0	OR	M	1	1	25.0	25.0
3N	M	1	1	26.0	26.0	OR	M	1	1	25.0	25.0
3N	M	1	1	26.0	26.0	OR	M	1	1	25.5	26.0
3N	F	2	1	24.0	24.0	OR	F	1	2	22.0	23.0
3N	F	1	2	24.5	25.0	OR	F	1	2	23.0	23.0
3N	F	1	2	25.0	25.0	OR	F	2	1	24.0	23.0
3N	M	2	1	24.0	24.0	OR	F	1	2	23.5	24.0
3N	M	2	1	24.0	24.0	OR	F	2	1	24.0	23.5
3N	M	1	2	25.0	24.5	OR	F	2	1	24.0	24.0
3N	M	1	2	25.0	24.5	OR	F	2	1	26.0	25.0
3N	M	2	1	25.0	24.5	OR	M	2	1	25.0	24.0
3N	M	1	2	25.0	25.0	OR	M	1	2	24.5	25.0
3N	M	2	1	25.0	25.0	OR	M	1	2	25.0	25.0
3N	M	2	1	25.5	25.5	OR	M	2	1	25.0	25.0
3N	M	1	2	25.5	26.0	OR	M	2	1	25.5	24.5
3N	M	2	1	26.0	26.0	OR	F	2	2	23.0	22.5
3N	M	2	1	27.0	26.0	OR	F	2	2	24.0	23.5
3N	F	3	1	24.0	23.5	OR	F	2	2	24.0	23.5
3N	F	2	2	25.0	25.0	OR	F	2	2	23.5	24.5
3N	F	2	2	26.0	26.0	OR	F	2	2	24.0	24.0
3N	M	2	2	22.5	23.0	OR	F	2	2	24.5	24.0

Appendix 9.5 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
3N	M	2	2	23.0	23.5	OR	F	2	2	25.0	24.5
3N	M	2	2	24.0	25.0	OR	M	2	2	23.5	23.5
3N	M	2	2	24.5	24.5	OR	M	2	2	24.0	23.5
3N	M	2	2	24.5	25.0	OR	M	1	3	24.0	24.0
3N	M	2	2	25.0	25.0	OR	M	2	2	24.0	24.0
3N	M	2	2	25.0	25.0	OR	M	2	2	24.0	24.5
3N	M	2	2	25.0	25.0	OR	M	2	2	24.5	25.0
3N	M	2	2	26.0	26.0	OR	M	2	2	24.5	25.0
3N	M	2	2	26.0	26.0	OR	M	2	2	25.0	25.0
3N	M	2	2	26.0	26.0	OR	M	2	2	25.0	25.5
3N	M	3	2	24.0	24.0	OR	M	2	2	25.5	25.0
3N	M	3	2	25.0	26.0	OR	M	3	1	26.0	25.5
3N	M	3	2	26.0	26.0	OR	F	3	2	25.5	24.5
3N	M	3	3	24.0	24.0	OR	F	3	3	23.0	23.0
3N	M	3	3	24.0	24.0	OR	M	3	3	24.0	24.5
3N	M	3	3	24.5	24.5	OR	M	3	3	25.0	25.0
3N	M	3	3	25.5	26.0	FS	F	0	0	21.0	21.0
OR	F	0	0	23.5	23.5	FS	F	0	0	22.0	22.5
OR	F	0	0	24.0	24.0	FS	F	1	0	21.0	22.0
OR	M	0	0	23.0	23.0	FS	F	1	0	23.0	23.0
OR	M	0	0	23.5	23.0	FS	F	1	1	21.0	21.0
OR	M	0	0	25.0	24.5	FS	F	1	1	22.0	23.0
OR	M	0	0	25.0	24.5	FS	F	1	1	22.0	23.0
OR	M	0	0	25.0	25.0	FS	F	1	1	23.0	23.0
OR	F	1	0	23.0	22.5	FS	F	2	1	22.5	22.5
OR	F	1	0	24.5	24.0	FS	F	1	2	23.0	22.5
OR	M	1	0	25.0	24.0	FS	F	1	2	23.0	23.0
OR	M	1	0	25.0	24.0	FS	F	3	2	23.0	23.0
OR	F	1	1	22.5	23.0	TS	F	1	0	25.5	25.0
OR	F	1	1	23.0	23.0	TS	M	1	0	24.5	25.0
OR	F	1	1	23.0	23.5	TS	M	0	1	25.0	25.0
OR	F	1	1	24.0	24.0	TS	M	0	1	26.5	27.0
OR	F	1	1	24.0	24.0	TS	M	1	0	27.5	27.0
OR	F	1	1	24.0	24.5	TS	F	1	1	25.0	25.0
OR	F	1	1	24.0	25.0	TS	F	1	1	25.0	25.0
OR	F	1	1	25.0	24.5	TS	F	1	1	26.0	26.0
OR	F	1	1	25.5	25.0	TS	F	1	1	26.0	26.0
OR	M	1	1	23.5	23.5	TS	F	1	1	26.0	26.0
OR	M	1	1	24.0	24.0	TS	F	0	2	26.5	26.5
OR	M	1	1	24.5	24.5	TS	F	1	1	26.5	26.5
TS	F	1	1	26.5	26.5	TS	M	1	1	26.5	26.0
TS	F	1	1	27.0	26.5	TS	M	1	1	26.5	27.0
TS	F	1	1	27.0	26.5	TS	M	0	2	27.0	27.0
TS	F	1	1	27.0	27.0	TS	F	2	1	25.5	25.0
TS	F	1	1	27.0	27.0	TS	F	2	1	27.0	27.0
TS	M	1	1	24.0	24.0	TS	F	2	1	27.0	27.0
TS	M	1	1	24.0	24.5	TS	M	1	2	24.5	24.5
TS	M	1	1	25.0	25.0	TS	M	2	1	25.0	25.0
TS	M	1	1	25.0	25.0	TS	M	1	2	25.5	25.5

Appendix 9.5 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Leg length Left	Leg length Right
TS	M	1	1	25.0	25.5	TS	M	2	1	26.0	26.0
TS	M	1	1	25.0	25.5	TS	M	2	1	27.5	27.5
TS	M	1	1	26.0	26.0	TS	F	2	2	27.0	27.0
TS	M	1	1	26.0	26.0	TS	M	2	2	25.0	25.0
TS	M	1	1	26.0	26.0	TS	M	2	2	25.5	25.5
TS	M	1	1	26.0	26.0	TS	M	2	2	26.0	26.0
TS	M	1	1	26.0	26.0	TS	M	2	2	26.5	27.0
TS	M	1	1	26.0	26.0	TS	M	2	2	28.0	28.0
TS	M	1	1	26.0	26.0	TS	M	2	2	28.0	28.0
TS	M	2	3	26.5	27.0						

Appendix 9.6: Coloured pigs: the farm ID sex mean bursitis score of each leg and hardness value from each leg.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
FP	F	0	0	4	5	FP	M	0	0	9	9
FP	F	0	0	4	5	FP	M	0	0	9	9
FP	F	0	0	4	6	FP	M	0	0	9	9
FP	F	0	0	5	5	FP	M	0	0	9	9
FP	F	0	0	5	5	FP	M	0	0	10	9
FP	F	0	0	5	5	FP	M	0	0	10	9
FP	F	0	0	5	6	FP	M	0	0	10	10
FP	F	0	0	5	6	FP	M	0	0	10	10
FP	F	0	0	5	6	FP	M	0	0	10	10
FP	F	0	0	6	5	FP	M	0	0	10	10
FP	F	0	0	6	5	FP	M	0	0	10	10
FP	F	0	0	6	6	FP	M	0	0	10	11
FP	F	0	0	6	6	FP	M	0	0	11	11
FP	F	0	0	6	6	FP	M	0	0	12	12
FP	F	0	0	6	6	FP	M	0	0	12	12
FP	F	0	0	6	6	1J	F	0	0	3	5
FP	F	0	0	6	6	1J	F	0	0	4	4
FP	F	0	0	7	6	1J	F	0	0	4	8
FP	F	0	0	6	8	1J	F	0	0	6	7
FP	F	0	0	7	7	1J	F	0	0	10	10
FP	F	0	0	7	7	1J	M	0	0	5	5
FP	F	0	0	7	7	1J	M	0	0	3	8
FP	F	0	0	7	8	1J	M	0	0	5	8
FP	F	0	0	9	6	1J	M	0	0	6	10
FP	F	0	0	8	8	1J	M	0	0	9	8
FP	F	0	0	8	9	1J	M	0	0	7	11
FP	F	0	0	8	9	1J	M	0	0	9	9
FP	F	0	0	9	8	1J	M	0	0	7	12
FP	F	0	0	8	1	1J	M	0	0	10	14
FP	F	0	0	9	9	1J	F	1	0	1	4
FP	F	0	0	9	9	1J	F	0	1	9	10
FP	F	0	0	10	8	1J	M	2	0	2	5
FP	F	0	0	11	8	1J	M	0	2	4	8
FP	F	0	0	10	1	2J	F	0	0	5	5
FP	F	0	0	10	1	2J	F	0	0	5	6
FP	F	0	0	10	1	2J	F	0	0	5	7
FP	F	0	0	10	1	2J	F	0	0	5	8
FP	F	0	0	10	1	2J	F	0	0	6	8
FP	F	0	0	11	9	2J	F	0	0	8	6
FP	F	0	0	12	8	2J	M	0	0	2	4
FP	M	0	0	3	4	2J	M	0	0	6	9
FP	M	0	0	5	5	2J	M	0	0	5	12
FP	M	0	0	5	6	2J	M	0	0	6	11
FP	M	0	0	5	6	2J	M	0	0	8	9
FP	M	0	0	5	7	2J	M	0	0	7	12
FP	M	0	0	6	6	2J	F	1	0	5	5
FP	M	0	0	6	6	2J	F	2	1	5	7

Appendix 9.6 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
FP	M	0	0	6	6	2J	M	0	0	3	2
FP	M	0	0	6	7	2J	M	0	0	3	2
FP	M	0	0	7	6	2J	M	0	0	3	5
FP	M	0	0	6	8	2J	M	0	0	3	5
FP	M	0	0	7	7	2J	M	0	0	4	4
FP	M	0	0	6	9	2J	M	0	0	4	4
FP	M	0	0	7	8	2J	M	0	0	4	5
FP	M	0	0	7	9	2J	M	0	0	5	5
FP	M	0	0	8	9	2J	M	0	0	5	6
FP	M	0	0	9	9	2J	M	0	0	7	6
FP	M	0	0	9	9	2J	M	0	0	7	8
2J	M	0	0	8	8	4J	F	2	1	3	5
2J	M	0	0	9	8	4J	F	3	0	4	5
2J	F	0	1	6	6	4J	F	2	1	6	7
2J	M	1	0	3	3	4J	F	2	1	7	8
2J	M	1	0	4	4	4J	F	2	1	9	10
2J	M	0	1	5	5	4J	M	2	1	7	5
2J	M	0	1	7	8	4J	F	3	1	4	4
2J	M	0	1	10	9	4J	F	2	2	5	4
2J	F	1	1	4	5	4J	M	3	3	7	7
2J	M	2	0	3	4	4J	F	0	0	9	10
2J	M	0	2	5	5	4J	F	0	0	10	9
2J	M	1	1	5	5	4J	M	0	0	10	9
2J	F	2	1	5	6	4J	F	0	1	4	5
2J	M	1	2	8	6	4J	F	0	1	5	6
2J	M	1	3	10	9	4J	F	1	0	5	6
2J	M	2	3	8	6	4J	F	1	0	6	5
4J	F	0	0	2	2	4J	F	1	0	7	5
4J	F	0	0	3	5	4J	F	1	0	6	7
4J	F	0	0	4	4	4J	F	0	1	6	8
4J	F	0	0	4	4	4J	F	1	0	6	8
4J	F	0	0	5	4	4J	F	1	0	8	7
4J	F	0	0	5	5	4J	F	0	1	10	8
4J	F	0	0	5	5	4J	F	0	1	10	8
4J	F	0	0	5	5	4J	F	1	1	5	5
4J	F	0	0	5	5	4J	F	1	1	6	4
4J	F	0	0	6	4	4J	F	1	1	5	6
4J	F	0	0	5	6	4J	F	1	1	5	6
4J	F	0	0	5	6	4J	F	1	1	6	6
4J	F	0	0	5	6	4J	F	2	0	6	6
4J	F	0	0	6	5	4J	F	1	1	6	7
4J	F	0	0	6	5	4J	F	1	1	7	7
4J	F	0	0	6	5	4J	F	1	1	7	8
4J	F	0	0	5	7	4J	F	1	1	7	9
4J	F	0	0	6	6	4J	M	1	1	4	3
4J	F	0	0	6	6	4J	M	0	2	8	9
4J	F	0	0	8	10	4J	F	2	1	2	4

Appendix 9.7: White pigs: the farm ID sex mean bursitis score of each leg and skin hardness value for each leg.

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
DD	F	1	1	3	3	3B	M	0	0	5	4
DD	M	1	1	7	7	3B	M	0	0	4	8
DD	M	2	1	4	5	3B	M	0	0	7	7
DD	M	1	2	5	5	3B	M	0	0	3	12
DD	M	2	1	6	6	3B	M	0	0	10	5
DD	F	3	1	3	1	3B	M	0	0	17	8
DD	F	2	2	4	4	3B	M	0	0	8	9
DD	F	2	2	6	6	3B	M	0	0	8	11
DD	F	2	2	8	9	3B	M	0	0	15	16
DD	F	2	2	12	8	3B	F	0	1	6	6
DD	M	2	2	2	1	3B	F	1	0	6	6
DD	M	2	2	5	6	3B	F	0	1	4	11
DD	M	2	2	6	7	3B	F	0	1	7	8
DD	M	2	2	6	8	3B	F	0	1	7	10
DD	F	3	2	4	4	3B	M	1	0	5	6
DD	F	3	2	10	11	3B	M	0	1	5	7
DD	M	3	2	2	3	3B	M	0	1	5	8
DD	M	3	2	4	5	3B	M	0	1	6	7
DD	M	2	3	8	8	3B	M	0	1	8	8
DD	F	3	3	5	4	3B	F	1	1	5	5
DD	F	3	3	5	5	3B	F	1	1	6	7
DD	F	3	3	5	5	3B	F	1	1	9	7
DD	F	3	3	6	8	3B	F	1	1	8	10
DD	F	3	3	8	9	3B	F	1	1	6	15
DD	M	3	3	5	5	3B	F	0	2	13	11
DD	M	3	3	5	5	3B	M	1	1	2	4
DD	M	3	3	6	6	3B	M	1	1	4	5
DD	M	3	3	6	7	3B	M	1	1	3	7
DD	M	3	3	6	8	3B	M	1	1	5	8
DD	M	3	3	8	6	3B	M	1	1	8	5
DD	F	5	2	12	3	3B	M	1	1	6	11
DD	F	3	4	6	5	3B	M	1	1	4	14
DD	M	4	3	5	8	3B	M	1	1	8	10
DD	M	3	4	10	4	3B	M	1	1	8	11
DD	F	5	5	5	4	3B	M	1	1	9	10
YV	F	0	0	5	5	3B	M	1	1	12	11
YV	M	0	0	4	3	3B	M	1	1	12	16
YV	M	0	0	6	6	3B	F	2	1	3	5
YV	F	0	1	6	5	3B	F	2	1	6	6
YV	F	0	1	6	6	3B	F	2	1	12	10
YV	F	1	0	12	12	3B	F	1	2	17	17
YV	M	1	0	6	7	3B	M	1	2	4	7
YV	F	1	1	8	7	3B	M	0	3	5	7
YV	F	0	2	9	8	3B	M	2	1	6	7
YV	F	1	1	8	9	3B	F	2	2	6	8
YV	F	2	2	6	8	3B	F	2	2	9	11
YV	F	5	2	5	6	3B	F	2	2	10	11

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Right	Skin hardness Left	Right	Farm ID	Sex	Bursitis score Left	Right	Skin hardness Left	Right
3B	F	0	0	4	6	3B	M	2	2	3	6
3B	F	0	0	5	5	3B	M	2	2	4	10
3B	F	0	0	5	6	3B	M	2	2	6	8
3B	F	0	0	6	6	3B	M	2	2	7	8
3B	F	0	0	5	8	3B	M	2	2	8	10
3B	F	0	0	5	8	3B	M	2	2	12	8
3B	F	0	0	6	7	3B	M	2	2	11	12
3B	F	0	0	3	11	3B	M	2	2	11	12
3B	F	0	0	7	9	3B	M	2	2	10	15
3B	F	0	0	7	10	3B	M	3	2	9	12
3B	F	0	0	7	11	3B	M	3	3	9	7
3B	F	0	0	16	15	4D	F	0	0	9	10
4D	F	0	0	9	11	HS	F	0	0	12	15
4D	F	0	0	11	11	HS	F	0	0	12	16
4D	F	0	0	11	11	HS	F	0	0	14	16
4D	F	0	0	11	12	HS	F	0	0	15	14
4D	F	0	0	12	12	HS	F	0	0	15	14
4D	F	0	0	14	14	HS	F	0	0	15	15
4D	M	0	0	7	6	HS	F	0	0	15	17
4D	M	0	0	10	10	HS	F	0	0	15	18
4D	M	0	0	10	10	HS	F	0	0	17	15
4D	M	0	0	10	11	HS	F	0	0	17	17
4D	M	0	0	11	12	HS	F	0	0	17	17
4D	F	1	0	8	9	4D	F	0	1	13	15
4D	F	1	0	9	8	HS	F	0	1	9	10
4D	F	0	1	11	10	HS	F	0	1	12	12
4D	F	0	1	11	12	HS	F	0	1	16	16
4D	F	0	1	11	12	HS	F	0	1	17	15
4D	F	0	1	13	13	4D	F	1	1	16	17
4D	F	0	1	13	14	2A	F	1	1	15	10
4D	M	0	1	10	9	HS	F	1	0	13	14
4D	M	1	0	11	10	HS	F	1	0	14	16
4D	M	0	1	12	11	HS	F	1	0	15	17
4D	F	1	1	9	10	HS	F	1	1	11	9
4D	F	1	1	10	9	HS	F	1	1	11	13
4D	F	1	1	11	11	HS	F	1	1	12	12
4D	M	1	1	11	9	HS	F	1	1	12	14
4D	M	1	1	12	11	HS	F	1	1	13	12
4D	M	1	1	13	13	HS	F	1	1	14	14
4D	F	2	1	8	8	HS	F	1	1	14	14
4D	F	1	2	10	9	HS	F	1	1	14	15
4D	F	1	2	11	12	HS	F	1	1	14	15
4D	F	1	2	12	13	HS	F	1	1	14	15
4D	M	2	1	9	9	HS	F	1	1	14	17
4D	M	1	2	9	10	HS	F	1	1	14	18
4D	M	2	1	9	10	HS	F	1	1	15	15
4D	M	2	1	9	12	HS	F	1	1	16	14
4D	F	2	2	10	10	HS	F	1	1	16	15
4D	F	2	2	10	11	HS	F	1	2	15	15

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
4D	F	2	2	11	10	HS	F	1	2	17	14
4D	F	2	2	11	10	HS	F	1	2	18	17
4D	F	2	2	11	12	HS	F	1	2	18	19
4D	F	2	2	12	12	4D	F	2	2	15	13
4D	F	2	2	13	13	4D	F	2	2	16	16
4D	M	2	2	9	8	2A	F	2	1	16	10
4D	M	2	2	10	10	2A	F	2	3	14	17
4D	M	2	2	10	10	HS	F	2	1	13	13
4D	F	2	3	7	7	HS	F	2	1	19	18
4D	F	3	2	9	9	HS	F	2	2	10	14
4D	F	2	3	11	9	HS	F	2	2	11	15
4D	F	2	3	11	12	HS	F	2	2	12	12
4D	M	2	3	10	11	HS	F	2	2	13	12
4D	M	2	3	11	12	HS	F	2	2	14	15
4D	F	3	3	9	11	HS	F	2	2	15	15
4D	M	3	3	11	11	HS	F	2	2	16	20
4D	M	5	2	12	12	HS	F	2	2	17	17
4D	F	0	0	12	15	HS	F	2	3	10	14
4D	F	0	0	16	18	4D	F	3	3	18	15
5F	F	0	0	9	9	2A	F	3	2	15	15
5F	F	0	0	15	15	BS	F	3	3	13	12
5F	F	0	0	15	17	HS	F	3	3	14	15
5F	F	0	0	18	18	HS	F	3	3	15	15
HS	F	0	0	9	11	AL	F	1	0	10	10
HS	F	0	0	11	13	AL	F	1	1	12	12
HS	F	0	0	12	15	AL	F	2	2	12	12
AL	F	2	2	12	12	2A	M	3	2	9	14
2A	M	3	3	12	13	2A	M	3	2	9	14
2A	M	3	3	12	13	2A	M	3	3	12	15
2A	M	3	3	12	15	2A	M	3	3	13	11
2A	M	3	3	13	11	2A	M	3	3	14	15
2A	M	3	3	14	15	BS	M	3	3	12	12
BS	M	3	3	12	12	HS	M	3	2	14	16
HS	M	3	2	14	16	HS	M	3	2	15	14
HS	M	3	2	15	14	HS	M	3	2	15	20
HS	M	3	2	15	20	HS	M	3	2	16	16
HS	M	3	2	16	16	HS	M	3	2	16	17
HS	M	3	2	16	17	HS	M	3	3	14	15
HS	M	3	3	14	15	2A	M	0	0	17	18
2A	M	0	0	17	18	HS	M	1	1	15	17
HS	M	1	1	15	17	AR	F	0	0	11	11
AR	F	0	0	11	11	AR	F	0	0	12	12
AR	F	0	0	12	12	AR	F	0	0	12	12
AR	F	0	0	12	12	AR	F	0	0	12	12
AR	F	0	0	12	12	AR	F	0	0	13	13
AR	F	0	0	13	13	AR	F	0	0	14	14
AR	F	0	0	14	14	AR	M	0	0	10	9
AR	M	0	0	10	9	AR	M	0	0	11	10
AR	M	0	0	11	10	AR	M	1	0	10	9

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Right	Skin hardness Left	Right	Farm ID	Sex	Bursitis score Left	Right	Skin hardness Left	Right
AR	M	1	0	10	9	AR	M	0	1	11	10
AR	M	0	1	11	10	AR	M	0	1	11	11
AR	M	0	1	11	11	AR	F	1	1	11	11
AR	F	1	1	11	11	AR	M	1	1	12	12
AR	M	1	1	12	12	AR	M	1	1	13	12
AR	M	1	1	13	12	5A	F	0	0	10	13
5A	F	0	0	10	13	5A	M	0	0	5	9
5A	M	0	0	5	9	5A	M	0	0	12	11
5A	M	0	0	12	11	5A	M	0	0	11	14
5A	M	0	0	11	14	5A	M	0	1	10	10
5A	M	0	1	10	10	5A	M	0	1	11	14
5A	M	0	1	11	14	5A	F	0	2	12	16
5A	F	0	2	12	16	5A	M	2	1	6	12
5A	M	2	1	6	12	5A	M	3	1	4	11
5A	M	3	1	4	11	AC	F	0	0	9	9
AC	F	0	0	9	9	AC	F	0	0	14	14
AC	F	0	0	14	14	AC	M	0	0	10	11
AC	M	0	0	10	11	AC	M	0	0	11	10
AC	M	0	0	11	10	AC	M	0	0	12	12
AC	M	0	0	12	12	AC	F	0	0	11	10
AC	F	0	0	11	10	AC	F	1	0	10	11
AC	F	1	0	10	11	AC	F	1	0	12	12
AC	F	1	0	12	12	AC	M	0	0	10	9
AC	M	0	0	10	9	AC	M	1	0	9	10
AC	M	1	0	9	10	AC	F	1	0	9	9
AC	F	1	0	9	9	AC	F	1	0	11	10
AC	F	1	0	11	10	AC	M	1	0	11	11
AC	M	1	0	11	11	AL	M	2	3	8	6
2A	M	0	0	12	12	ID	M	1	0	11	10
2A	M	0	0	15	15	ID	F	0	0	10	9
5F	M	0	0	15	17	ID	F	1	0	10	10
HS	M	0	0	11	12	ID	F	1	0	11	9
HS	M	0	0	11	15	ID	F	1	0	12	10
HS	M	0	0	12	14	ID	F	1	0	14	14
HS	M	0	0	14	12	ID	M	1	0	9	9
HS	M	0	0	15	15	ID	M	1	0	9	9
HS	M	0	0	15	18	ID	M	1	0	11	10
HS	M	0	0	16	14	ID	M	1	0	12	9
HS	M	0	0	17	17	ID	M	1	0	10	12
HS	M	0	2	15	17	ID	M	1	0	11	11
4D	M	1	2	16	16	ID	F	2	0	10	9
4D	M	1	2	17	16	ID	F	2	0	10	9
2A	M	1	0	15	12	ID	F	2	0	11	10
2A	M	1	1	12	12	ID	M	2	0	12	11
2A	M	1	1	14	12	ID	M	1	2	12	12
2A	M	1	1	16	16	ID	F	2	2	11	11
2A	M	1	1	17	14	ID	F	2	2	12	12
2A	M	1	1	17	15	ID	M	2	2	13	12
5F	M	1	1	15	15	ID	M	3	1	14	14

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
5F	M	1	1	17	16	ID	F	2	3	11	10
BS	M	1	1	16	16	4D	F	0	0	9	9
HS	M	1	0	11	14	4D	F	0	0	11	9
HS	M	1	1	11	14	4D	F	0	0	10	11
HS	M	1	1	12	12	4D	F	0	0	11	13
HS	M	1	1	12	14	4D	M	0	0	8	7
HS	M	1	1	14	14	4D	M	0	0	9	10
HS	M	1	1	16	14	4D	F	1	0	9	10
HS	M	1	1	17	13	4D	F	0	1	10	10
HS	M	1	1	17	17	4D	M	1	0	5	9
HS	M	1	1	18	20	4D	M	1	0	10	10
HS	M	1	2	9	10	4D	M	0	1	11	11
4D	M	2	2	12	16	4D	F	2	0	8	8
4D	M	2	3	13	14	4D	F	1	1	9	9
2A	M	2	1	12	10	4D	F	1	1	9	9
2A	M	2	2	12	12	4D	F	1	1	10	9
2A	M	2	2	13	12	4D	F	1	1	10	9
2A	M	2	2	14	13	4D	F	1	1	9	11
2A	M	2	2	15	14	4D	F	1	1	11	11
2A	M	2	2	17	15	4D	M	1	1	9	11
2A	M	2	3	15	12	4D	M	1	1	11	11
2A	M	2	3	16	14	4D	M	0	2	11	12
2A	M	2	3	19	19	4D	F	2	1	11	11
BS	M	2	2	16	17	4D	M	2	1	10	10
BS	M	2	2	16	17	4D	M	2	1	11	11
HS	M	2	2	15	14	4D	M	2	1	12	13
HS	M	2	2	15	15	4D	F	2	2	11	11
HS	M	2	2	17	16	4D	F	2	2	11	11
HS	M	2	3	8	10	4D	M	2	2	10	9
AC	M	1	0	12	10	4D	M	2	2	11	11
AC	F	2	0	9	10	4D	M	2	2	12	11
ID	F	0	0	11	9	4D	M	2	3	10	10
ID	F	0	0	11	9	4D	M	2	3	11	11
ID	F	0	0	12	12	SD	F	0	0	6	6
ID	M	0	0	11	12	SD	F	0	0	6	6
ID	F	0	0	10	10	SD	F	0	0	7	7
ID	F	0	0	10	10	SD	F	0	0	7	7
SD	F	0	0	8	9	AH	M	0	0	10	9
SD	F	0	0	9	10	AH	M	0	0	9	11
SD	F	0	0	10	11	AH	M	0	0	10	10
SD	F	0	0	13	12	AH	M	0	0	10	10
SD	M	0	0	6	8	AH	M	0	0	10	10
SD	M	0	0	9	7	AH	M	0	0	10	10
SD	M	0	0	10	7	AH	M	0	0	10	10
SD	F	0	0	3	5	AH	M	0	0	10	10
SD	F	0	0	5	4	AH	M	0	0	10	10
SD	F	0	0	5	5	AH	M	0	0	10	10
SD	F	0	0	6	5	AH	M	0	0	10	10
SD	F	0	0	5	7	AH	M	0	0	10	10

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
SD	F	0	0	5	8	AH	M	0	0	10	10
SD	F	0	0	5	9	AH	M	0	0	11	9
SD	F	0	0	4	12	AH	M	0	0	10	11
SD	F	0	0	6	10	AH	M	0	0	10	11
SD	F	0	0	8	11	AH	M	0	0	10	11
SD	F	0	0	9	11	AH	M	0	0	11	10
SD	F	0	0	8	13	AH	M	0	0	11	10
SD	M	0	0	3	5	AH	M	0	0	10	12
SD	M	0	0	4	5	AH	M	0	0	11	11
SD	M	0	0	6	5	AH	M	0	0	11	11
SD	M	0	0	6	6	AH	M	0	0	11	11
SD	M	0	0	6	6	AH	M	0	0	12	12
SD	M	0	0	7	6	AH	M	0	0	12	12
SD	M	0	0	6	8	AH	M	0	0	12	12
SD	M	0	0	7	9	AH	M	0	0	12	12
SD	M	0	0	8	10	AH	M	0	0	12	13
SD	M	0	0	9	9	AH	M	0	0	13	13
SD	M	0	0	9	9	AH	M	0	0	13	13
SD	M	0	0	10	8	AH	M	0	0	13	13
SD	M	0	0	6	15	AH	M	1	0	9	10
SD	M	0	0	10	12	AH	M	0	1	11	11
SD	M	0	0	10	14	AH	M	0	1	11	11
SD	M	0	0	16	15	AH	M	0	1	11	13
SD	F	1	0	7	7	AH	M	1	1	9	9
SD	F	1	0	6	12	AH	M	1	1	11	11
SD	M	1	0	3	5	IL	F	0	0	12	12
SD	M	0	1	6	14	IL	M	0	0	6	8
SD	F	1	1	8	9	IL	M	0	0	7	8
SD	M	1	1	9	8	IL	M	0	0	8	7
SD	F	1	1	9	5	IL	M	0	0	9	9
SD	M	1	1	9	12	IL	M	0	0	9	10
SD	M	1	2	10	18	IL	M	0	0	10	9
AH	M	0	0	9	7	IL	M	0	0	10	10
AH	M	0	0	9	7	IL	M	0	0	11	13
AH	M	0	0	9	9	IL	F	0	1	10	11
AH	M	0	0	9	9	IL	F	1	1	9	11
AH	M	0	0	9	10	IL	F	1	1	11	12
AH	M	0	0	9	10	IL	F	1	1	13	14
AH	M	0	0	10	9	IL	F	1	2	8	9
AH	M	0	0	10	9	IL	F	2	1	10	10
IL	M	2	1	8	7	IL	F	2	2	9	9
IL	M	1	2	8	10	IL	M	3	1	9	8
IL	M	1	2	9	9	IL	M	2	2	9	9
IL	M	2	1	11	13	IL	M	2	2	10	11
IL	F	2	2	6	6	IL	M	2	2	15	15
IL	F	2	2	9	9	IL	F	2	3	8	8
IL	M	2	3	7	8	1M	F	2	1	11	10
IL	M	3	2	13	13	1M	F	2	1	12	11
IL	F	3	3	9	8	1M	F	1	2	12	12

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
IL	M	3	3	9	9	1M	F	2	1	13	13
IL	M	3	3	9	11	1M	F	1	2	12	15
IL	M	3	3	10	10	1M	M	1	2	1	9
IL	M	3	3	14	14	1M	M	2	1	7	8
IL	F	4	3	9	9	1M	M	1	2	9	9
1M	F	0	0	9	10	1M	M	2	1	10	9
1M	F	0	0	8	12	1M	M	2	1	10	11
1M	F	0	0	10	10	1M	M	1	2	13	14
1M	F	0	0	10	10	1M	F	2	2	8	7
1M	F	0	0	11	10	1M	F	2	2	10	10
1M	F	0	0	11	10	1M	F	2	2	11	11
1M	F	0	0	11	11	1M	F	2	2	11	11
1M	F	0	0	12	12	1M	F	2	2	12	10
1M	M	0	0	6	5	1M	F	2	2	13	11
1M	M	0	0	9	7	1M	M	2	2	8	9
1M	M	0	0	9	8	1M	M	2	2	8	10
1M	M	0	0	9	10	1M	M	2	2	9	10
1M	M	0	0	10	9	1M	M	2	2	9	11
1M	M	0	0	10	9	1M	M	2	2	9	12
1M	M	0	0	9	11	1M	F	2	3	8	8
1M	M	0	0	10	10	1M	F	3	2	14	14
1M	M	0	0	11	11	1M	M	2	3	8	8
1M	M	0	0	13	12	1M	M	3	2	9	10
1M	F	0	1	11	11	1M	M	2	3	11	11
1M	F	0	1	11	11	1M	F	3	3	11	14
1M	F	1	0	11	11	1M	M	3	3	9	9
1M	M	0	1	10	10	3N	F	0	0	5	6
1M	M	1	0	10	10	3N	M	0	0	5	6
1M	M	0	1	11	10	3N	M	0	0	8	6
1M	M	1	0	10	11	3N	M	1	0	6	6
1M	M	1	0	11	11	3N	F	0	2	6	4
1M	M	1	0	13	9	3N	F	1	1	6	8
1M	M	0	1	12	12	3N	F	2	0	10	9
1M	F	1	1	7	7	3N	M	1	1	5	5
1M	F	1	1	9	9	3N	M	1	1	5	8
1M	F	1	1	9	10	3N	M	1	1	6	7
1M	F	1	1	10	9	3N	M	1	1	9	10
1M	F	1	1	10	10	3N	M	1	1	9	11
1M	F	1	1	10	10	3N	F	1	2	4	3
1M	F	1	1	11	11	3N	F	1	2	5	5
1M	F	1	1	12	10	3N	M	1	2	5	4
1M	F	1	1	12	12	3N	F	2	2	4	4
1M	M	1	1	8	9	3N	F	3	1	5	5
1M	M	1	1	9	9	3N	M	2	2	3	8
1M	M	1	1	8	11	3N	M	2	2	6	6
1M	M	1	1	10	9	3N	M	2	2	7	8
1M	M	1	1	10	11	3N	M	2	2	7	10
1M	M	1	1	10	11	3N	M	3	2	3	3
1M	M	1	1	11	11	3N	F	3	3	8	5

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
1M	M	1	1	11	12	3N	M	3	3	3	8
1M	M	1	1	12	12	3N	M	4	3	3	5
1M	M	2	0	14	13	OR	F	0	0	5	4
1M	F	1	2	9	7	OR	F	0	0	4	6
1M	F	1	2	11	8	OR	F	0	0	6	6
1M	F	2	1	10	9	OR	F	0	0	9	7
OR	F	0	0	10	10	OR	M	1	1	7	9
OR	F	0	0	10	12	OR	M	1	1	8	8
OR	F	0	0	11	11	OR	M	1	1	9	9
OR	F	0	0	11	11	OR	M	1	1	10	8
OR	F	0	0	11	11	OR	M	1	1	9	10
OR	F	0	0	11	11	OR	M	1	1	9	11
OR	M	0	0	4	4	OR	M	1	1	10	10
OR	M	0	0	3	6	OR	M	1	1	11	10
OR	M	0	0	6	4	OR	M	1	1	12	10
OR	M	0	0	5	5	OR	F	1	2	4	5
OR	M	0	0	4	7	OR	F	1	2	7	6
OR	M	0	0	4	7	OR	F	1	2	6	8
OR	M	0	0	7	7	OR	F	2	1	6	10
OR	M	0	0	8	8	OR	F	2	1	10	9
OR	M	0	0	10	10	OR	F	1	2	10	10
OR	M	0	0	12	10	OR	F	1	2	10	10
OR	M	0	0	12	13	OR	F	1	2	10	11
OR	M	0	0	15	13	OR	F	2	1	11	11
OR	F	0	1	4	6	OR	F	2	1	10	12
OR	F	0	1	6	5	OR	F	1	2	14	14
OR	F	0	1	9	10	OR	M	2	1	6	5
OR	F	0	1	11	10	OR	M	2	1	7	5
OR	F	1	0	11	12	OR	M	1	2	6	7
OR	F	1	0	12	11	OR	M	2	1	7	7
OR	M	1	0	3	6	OR	M	1	2	9	9
OR	M	1	0	5	6	OR	M	1	2	9	10
OR	M	0	1	6	6	OR	M	1	2	11	9
OR	M	1	0	4	8	OR	M	2	1	11	10
OR	M	1	0	9	7	OR	M	1	2	11	11
OR	M	0	1	10	9	OR	M	2	1	11	11
OR	M	0	1	8	12	OR	M	1	2	13	12
OR	M	1	0	11	10	OR	M	0	3	13	13
OR	M	0	1	11	11	OR	F	2	2	5	4
OR	M	0	1	11	12	OR	F	3	1	5	5
OR	M	1	0	11	12	OR	F	2	2	5	6
OR	F	1	1	4	5	OR	F	2	2	6	6
OR	F	1	1	4	6	OR	F	2	2	8	5
OR	F	2	0	8	4	OR	F	3	1	10	11
OR	F	1	1	5	8	OR	F	2	2	11	11
OR	F	1	1	7	6	OR	F	2	2	10	14
OR	F	1	1	8	7	OR	F	2	2	13	12
OR	F	1	1	9	10	OR	M	2	2	4	7
OR	F	1	1	9	10	OR	M	2	2	5	6

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
OR	F	1	1	10	10	OR	M	2	2	7	5
OR	F	1	1	10	10	OR	M	2	2	5	8
OR	F	1	1	10	11	OR	M	2	2	5	10
OR	F	1	1	11	11	OR	M	2	2	6	9
OR	F	1	1	12	13	OR	M	2	2	9	10
OR	F	1	1	12	13	OR	M	2	2	9	10
OR	F	1	1	14	13	OR	M	2	2	11	9
OR	F	1	1	14	14	OR	M	2	2	10	10
OR	M	1	1	4	6	OR	M	2	2	11	9
OR	M	1	1	5	5	OR	M	2	2	11	10
OR	M	1	1	6	6	OR	M	2	2	12	12
OR	M	1	1	7	6	OR	M	2	2	12	12
OR	M	1	1	7	8	OR	M	2	2	12	13
OR	M	2	2	12	13	OR	F	2	3	7	6
OR	F	2	3	10	12	PS	F	2	3	9	11
OR	F	2	3	11	11	PS	M	3	2	10	10
OR	F	2	3	11	11	PS	M	1	5	11	12
OR	F	2	3	12	12	PS	F	5	5	13	13
OR	M	2	3	8	7	5T	F	0	0	5	5
OR	M	2	3	7	9	5T	F	0	0	4	7
OR	M	2	3	9	9	5T	F	0	0	6	5
OR	M	3	2	11	10	5T	F	0	0	7	5
OR	M	3	2	11	11	5T	F	0	0	9	12
OR	M	3	2	14	14	5T	F	0	0	10	15
OR	F	5	1	4	7	5T	M	0	0	2	7
OR	F	3	3	14	13	5T	M	0	0	3	6
OR	M	3	3	3	4	5T	M	0	0	6	6
OR	M	1	5	6	5	5T	M	0	0	5	8
OR	M	3	3	6	6	5T	M	0	0	5	10
OR	M	5	1	8	6	5T	M	0	0	7	8
OR	M	3	3	9	10	5T	M	0	0	3	15
OR	M	3	3	9	11	5T	M	0	0	4	14
OR	M	3	3	10	10	5T	M	0	0	7	12
OR	M	3	3	10	11	5T	M	0	0	11	10
OR	M	3	3	11	11	5T	F	1	0	4	5
OR	M	3	3	12	12	5T	F	0	1	7	7
OR	M	3	3	13	13	5T	F	0	1	4	15
OR	F	3	5	10	11	5T	F	1	0	10	15
OR	F	5	5	7	8	5T	M	1	1	7	3
OR	F	5	5	8	9	5T	M	1	1	4	10
OR	M	5	5	6	5	5T	M	1	1	12	18
OR	M	5	5	6	6	5T	F	1	2	6	7
OR	M	5	5	11	12	5T	M	1	2	6	7
HS	F	0	0	7	6	5T	M	2	1	6	7
HS	F	0	0	10	9	5T	M	1	2	11	16
HS	F	0	0	11	10	5T	F	2	2	5	5
HS	F	0	0	11	12	5T	F	2	2	5	8
HS	F	1	0	9	11	5T	F	2	2	6	8
HS	M	0	1	12	12	5T	M	2	2	6	4

Appendix 9.7 (Contd.)

Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right	Farm ID	Sex	Bursitis score Left	Bursitis score Right	Skin hardness Left	Skin hardness Right
HS	M	1	0	13	11	5T	F	3	2	4	6
HS	M	1	1	9	11	5T	M	3	2	5	17
HS	M	1	1	10	12	5T	M	3	3	3	7
HS	F	3	0	15	12	0X	M	0	0	9	9
HS	M	1	2	8	7	0X	M	0	0	11	12
HS	M	2	1	10	7	0X	M	0	0	11	13
HS	F	2	2	15	15	0X	M	0	0	12	12
HS	F	2	2	17	14	0X	M	0	1	9	10
HS	M	2	2	10	11	0X	M	1	0	9	10
HS	M	3	1	11	10	0X	M	1	0	11	10
HS	F	2	3	7	10	0X	M	0	1	12	12
HS	M	2	3	7	12	0X	F	1	1	11	10
HS	M	2	3	10	12	0X	M	0	2	11	11
HS	M	2	3	13	14	0X	M	1	1	12	12
HS	F	3	3	10	12	0X	F	2	1	10	7
PS	F	0	0	11	10	0X	M	2	1	9	11
PS	F	1	0	11	11	0X	M	2	1	11	10
PS	M	1	1	10	10	0X	M	1	2	11	11
PS	M	1	1	11	12	0X	M	2	1	11	12
PS	M	2	1	11	9	0X	M	1	2	13	11
PS	M	2	1	13	12	0X	F	2	2	9	9
PS	F	2	2	10	9	0X	F	2	2	13	13
PS	M	2	2	11	10	0X	M	2	2	9	10
PS	M	2	2	11	11	0X	M	2	2	11	10
0X	M	2	2	11	12	AA	F	0	0	9	9
0X	M	2	2	12	12	AA	F	0	0	10	10
0X	M	2	3	13	13	AA	M	0	0	12	11
0X	M	3	3	9	10	AA	F	1	1	6	6
AA	F	0	0	9	8	AA	M	1	1	7	6
AA	F	1	2	8	7						

Appendix 9.8: Statistical analysis: The effect of skin hardness on bursitis

******* Regression Analysis *******

Response variate: avscowr
Fitted terms: Constant + slapwr + avhwr

***** Summary of analysis *****

	d.f.	s.s.	m.s.	v.r.
Regression	14	101.8	7.2747	8.08
Residual	705	635.0	0.9007	
Total	719	736.8	1.0248	
Change	-1	-1.0	0.9803	1.09

Percentage variance accounted for 12.1

* MESSAGE: The following units have large standardized residuals:

623	3.74
624	3.72
625	3.78
626	3.77
627	3.67
661	3.38

* MESSAGE: The following units have high leverage:

649	0.077
650	0.077
651	0.077
652	0.077
653	0.077
654	0.078
655	0.077
656	0.077
657	0.077
658	0.077
659	0.077
660	0.077
661	0.078

***** Accumulated analysis of variance *****

Change	d.f.	s.s.	m.s.	v.r.
+ slapwr	13	100.8656	7.7589	8.63
+ avhwr	1	0.9803	0.9803	1.09
+ sexwr	1	1.8351	1.8351	2.04
+ slapwr.sexwr	13	8.1529	0.6271	0.70
+ avhwr.slapwr	13	9.6849	0.7450	0.83
+ avhwr.sexwr	1	0.9411	0.9411	1.05
+ avhwr.slapwr.sexwr	13	17.4993	1.3461	1.50
Residual	664	596.8738	0.8989	
Total	719	736.8330	1.0248	

Appendix 10.1: The farm ID, no. of pigs per farm, mean bursitis score and no. of pigs trimmed on the left leg, right leg or both legs.

Farm ID	Total pigs	Average bursitis score	No. trimmed (Left)	No. trimmed (Right)	No. trimmed (Both)	Total trimmed
Abattoir A						
Y8	58	2.314	5	9	8	22
BO	24	2.135	1	4	4	9
AR	56	2.137	4	8	10	22
CH	24	1.267	1	3	2	6
DS	41	1.362	0	1	1	2
X0	61	2.000	1	3	2	6
PE	50	2.659	0	5	6	11
WS	24	1.879	1	4	0	5
BA	8	1.000	0	1	0	1
MF	18	1.113	0	1	1	2
MR	46	1.613	0	6	4	10
SB	58	2.017	3	2	9	14
AT	19	1.570	0	1	0	1
FB	20	1.755	0	2	1	3
B3	42	1.822	1	0	0	1
KI	11	1.897	0	0	3	3
KI	33	1.897	0	2	3	5
UY	64	2.110	2	2	4	8
MO	17	1.912	3	2	4	9
G7	20	1.784	1	0	1	2
M1	18	2.044	0	0	0	0
GA	23	2.264	0	2	4	6
IS	0	0.000	0	0	0	0
S1	30	1.543	0	3	1	4
S1	11	1.356	0	0	0	0
F3	39	1.833	0	1	2	3
T5	12	1.043	0	0	0	0
U1/U2	34	2.115	9	4	7	20
U1/U2	120	2.115	12	15	23	50
U1/U2	58	2.115	0	0	1	1
N3	67	1.765	0	0	0	0
N3	61	1.765	6	2	6	14
DC	82	2.077	10	5	17	32
DD	53	1.651	0	0	0	0
Y8	48	2.314	4	3	22	29
Y8	13	2.314	2	0	4	6
Y8	22	2.314	0	0	0	0
HE	9	0.588	0	0	0	0
HE	66	0.588	0	0	0	0
AR	16	0.000	0	0	6	6

Appendix 10.1:(Contd.)

Farm ID	Total pigs	Average bursitis score	No. trimmed (Left)	No. trimmed (Right)	No. trimmed (Both)	Total trimmed
Abattoir A (contd.)						
B3	16	1.822	0	0	0	0
SL	17	1.980	1	1	4	6
DR	14	1.551	0	2	9	11
DR	20	1.551	0	2	12	14
RI	81	1.220	0	8	4	12
M4	13	1.380	0	1	2	3
WO	18	2.420	0	0	0	0
N/S	24	1.020	0	0	0	0
LA	24	1.750	0	4	2	6
12	15	2.200	1	2	4	7
77	44	1.870	3	1	3	7
AR	40	1.180	0	2	0	2
A1	13	0.650	0	0	0	0
MW	35	0.000	2	1	0	3
Abattoir B						
CA	43	2.023	3	2	9	14
RR	34	0.000	0	0	2	2
HF	36	2.205	2	2	7	11
JG	15	1.244	1	0	0	1
VI	81	2.250	8	8	28	44
AR	53	0.000	2	2	11	15
KE	28	0.000	0	2	3	5
LA	22	1.847	0	1	2	3
L1	44	1.443	2	4	8	14
F5	46	1.730	1	0	5	6
RA	11	0.000	0	0	0	0

Appendix 10.2: Statistical analysis: The number of pigs trimmed and mean bursitis score.

******* Regression Analysis *******

Response variate	:	no affect
Binomial totals	:	no pigs
Distribution	:	Binomial
Link function	:	Logit
Fitted terms	:	Constant, abattoir

***** Summary of analysis *****

	d.f.	deviance	Mean deviance	deviance ratio
Regression	1	17.8	17.773	2.28
Residual	58	452.9	7.808	
Total	59	470.7	7.977	
Change	-1	-17.8	17.773	2.28

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	-1.325	0.160	-8.28
abattoir BROX	0.561	0.363	1.55

******* Regression Analysis *******

Response variate	:	no affect
Binomial totals	:	no pigs
Distribution	:	Binomial
Link function	:	Logit
Fitted terms	:	Constant, abattoir, avbscore

***** Summary of analysis *****

	d.f.	deviance	Mean deviance	deviance ratio
Regression	2	117.1	58.565	9.44
Residual	57	353.5	6.202	
Total	59	470.7	7.977	
Change	-1	-99.4	99.357	16.02

Appendix 10.2 (Contd.)

***** Estimates of regression coefficients *****

	Estimate	s.e.	t
Constant	-3.929	0.743	-5.29
abattoir BROX	0.516	0.330	1.57
avbscore	1.381	0.374	3.70

***** Accumulated analysis of deviance *****

Change			Mean deviance	deviance
	d.f.	deviance	deviance	ratio
+ abattoir	1	17.773	17.773	2.87
+ avbscore	1	99.357	99.357	16.02
Residual	57	353.525	6.202	
Total	59	470.655	7.977	

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